VENTILATING

A MONTHLY MAGAZINE FOR ENGINEERS AND CONTRACTORS CONCERNED WITH COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL AIR CONDITIONING, REFRIGERATION, AIR SANITATION, PIPING, HEATING AND VENTILATION

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THIS MONTH'S COVER

Photo shows Warren Webster radiant baseboard installation in private home. See symposium on baseboard heating beginning page 75.

TESTED IN WAR

FOUR STARS
ON OUR E PENNANT
TESTIFY TO SARCO
PERFORMANCE
IN THE WAR EFFORT

Three important facts will emerge from the war effort—thrice recognized by the Army and Navy E:

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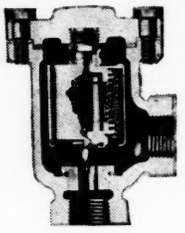
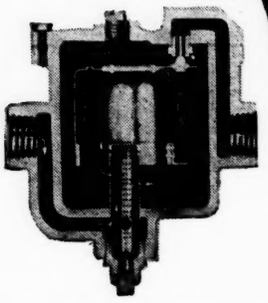
3. The urge for mass production of war material with high accuracy and speed has brought about new applications of Sarco products. The result: modernization of your steam and hot water facilities can set your plant ahead by about ten years!

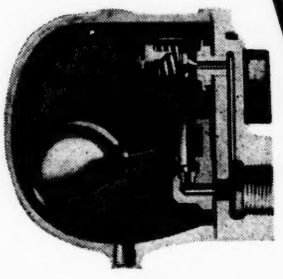
A few reminders of Sarco Service are illustrated on these pages. Let's look at a few of the developments that will improve your product, speed your production and lower your fuel and metered water costs. Ask for the Sarco Hook-Up Book.



The New Sarco No. 9 Thermostatic Steam Trap with high efficiency and capacities. Bulletin No 250.



Sarco Bucket Steam Trap—for pressures up to 900 lbs Bulletin No 350



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Washington News

LORING F. OVERMAN

Twilight of a bureau.
Construction limits ended.
To price or not to price.
Mr. Bowles explains building prices.
Strikes complicate reconversion.

TODAY the hallways of WPB seem virtually deserted. Skeleton crews occupy offices with acres of idle desks and silent typewriters. And as this column goes to press there were bets being taken that the entire War Production Board, as such, would be extinct within a matter of days.

Two Bureaus Likely

Indications were that early in October some 3,500 WPB employees would be absorbed, along with holdover duties, by the Office of War Mobilization and Reconversion, and that WPB itself would be discontinued in favor of two new bureaus.

One, the Reconversion Bureau, would continue to manage such scarcities as tin, lumber, chemicals and rubber, and would assist in breaking bottlenecks impeding reconversion. The other, a Demobilization Bureau, would liquidate WPB itself and arrange for the shifting of needed personnel and industry committees to other Government agencies.

Reason for WPB's hastened departure, surprising as it may be to some who predicted that all government agencies would seek to perpetuate themselves, is that it has simply revoked itself out of a job. With CMP out on September 30, together with the AA Priorities system, and with all but a handful of more than 500 Limitation and Conservation Orders and Schedules stricken from the records, WPB does hardly enough business to justify a phone bill. Or at any rate, anything it expects to have to do in the future, can be done with a fraction of its original staff, and from the offices of the permanent agencies having jurisdiction during peacetime.

Clean Sweep Indicated

With the expected absorption of WPB by OWMR, observers were anticipating the dropping of all priority regulations remaining; ending of all production controls in a small group of textiles, chemicals and minor items, and ending of all distribution controls except those limiting inventory and those pertaining to tin and some imported materials in short supply.

With the possible exception of tin, none of the controls outstanding at press time was of concern to the heating, ventilating and air conditioning industries, which were technically freed of all restrictions with the passing of CMP on September 30.

In what will probably be one of the last official acts of WPB, it issued Interpretation 1 to Priorities Regulation 29, to explain that orders rated AA and originally scheduled for delivery by September 30 but which due to circumstances beyond the supplier's control were delayed in delivery, will be void after the deadline date and must be treated as unrated orders. In other words, delivery schedules are now a matter for settlement between the buyer and seller —unless an MM (military) rating or a CC (bottleneck buster) directs otherwise.

L-41 Termination

Of major concern to all affiliated with heating, ventilating and air conditioning industries was the revocation, effective October 15, of Construction Order L-41. Although previous amendments to the order had cleared the way for many types of construction, complete revocation of all remaining restrictions had not been expected for some months. The permitted group now includes residences, hotels, apartments, hospitals, commercial buildings, factories —everything in the building category, public and private.

Again, however, advancing of the termination date of the order may prove more of a gesture than an actuality, for building material shortages have by no means been solved.

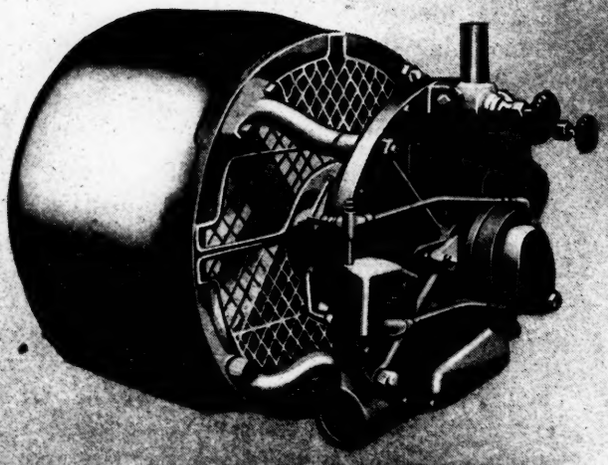
"Since the lead factor in most construction is about four months and the winter season is coming on, it is our opinion that the restrictions of Order L-41 can be lifted on October 15 without dangerous risk," explained J. A. Krug, Chairman of the War Production Board. "The various agencies of government are cooperating to increase production of key construction materials . . . Due to these efforts, which include price and wage adjustments in a number of cases, . . . we believe that during the next six months production will exceed actual consumption. At the same time, inventories in distribution channels will be increasing slowly.

Mr. Krug's rather optimistic prediction, which was made prior to opening of the West Coast lumbermen's strike, warned that construction not urgently needed should be deferred for the balance of the year unless there is reasonable assurance locally that materials will be available to complete the work. Besides lumber, Mr. Krug listed as tight items brick, cast iron pipe, gypsum board, clay sewer pipe, structural tile and asphalt roofing materials.

Standards Revoked

Coincident with the revocation of L-41, the WPB also removed restrictions on the use of critical materials and equipment, with the exception of lead and tin. Action was taken by revocation of Schedule I (War Housing Critical List) and Schedule II (War Housing Construction Standards) to Order P-55-c. Schedule I listed materials and equipment currently in short supply, and prohibited or restricted their use. Chief among items covered were plumbing, water and gas installations; elevators and escalators, lead and lead products, lumber, and insect screen cloth. Use of lead and tin is still limited by Order

WING



WING TURBINE DRIVEN BLOWERS

Type K

For Brickwall Mounting

Generally used for Stoker or Bagasse Firing where casing is cemented into Boiler Wall

Wing pioneered in forced-draft turbine blowers over a third of a century ago. Today Wing Turbine Blowers are in use in thousands of installations in many varied industries. They are simple and rugged in construction, quiet and dependable in operation. Oil-free exhaust can be used for heating, process or feed water.

WING TURBINE [illegible] BLOWERS

Type [illegible]

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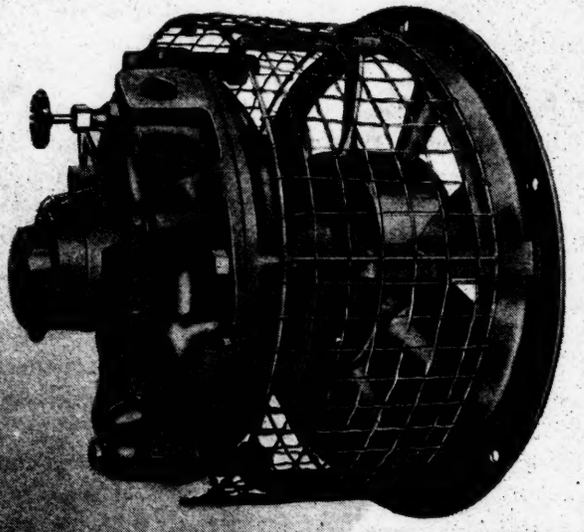

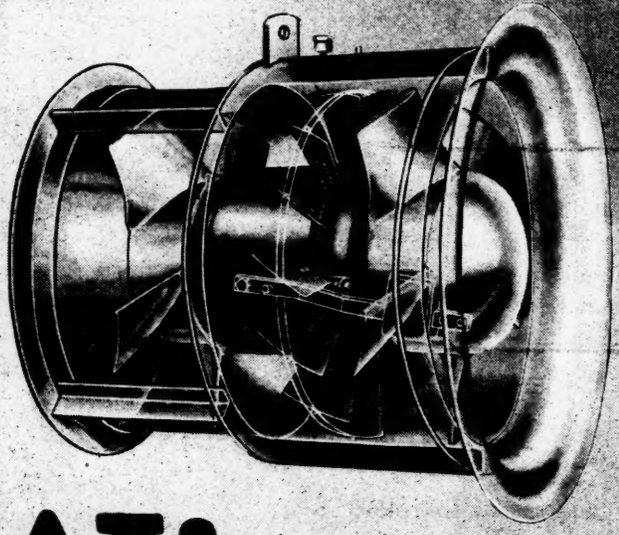

[illegible] MOTOR DRIVEN BLOWERS

TYPE COM (TWO STAGE)

TYPE EMD (SINGLE STAGE)

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Write for Bulletin SW-1

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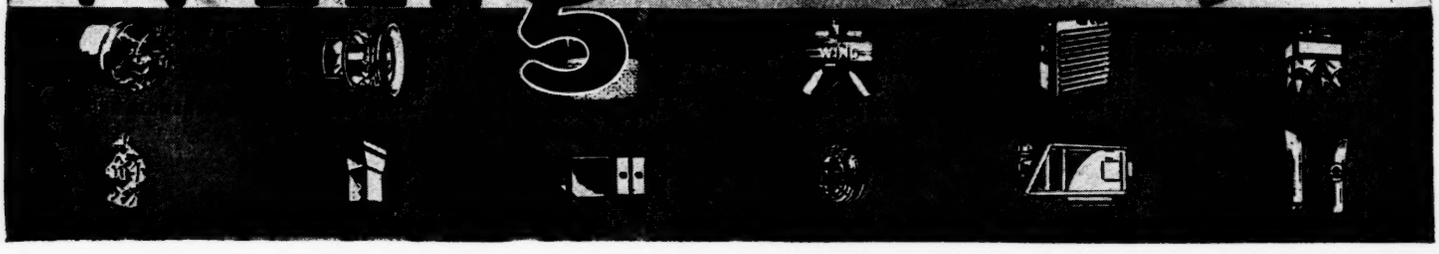
Wing AXIAL [illegible] BLOWERS



M-38 (lead) and M-43 (tin). Schedule 11 imposed restrictions on the design of new housing and also restricted the use of lumber and the installation of plumbing.

Pricing Muddle

While many within WPB contend that the lifting of home, commercial and public works restrictions of L-41 was premature, that controversy is dwarfed by the one involving pricing policies.

Meeting head on are the OPA viewpoint that uncontrolled residential prices will result in explosive inflation in the building industry, and those who oppose granting Price Administrator Bowles any jurisdiction over finished prices in this field. Bowles contends that if prices are too high buyers will balk and the construction program will not produce the employment and national income predicted and required for continued prosperity. Opponents counter that if prospective builders cannot see a profit inducement for risking capital the construction program will lag and the net result will be the same as when arguing from the Bowles premise.

Materials Pricing

Regardless of the outcome of the residential sales price battle (the decision will doubtless affect *all* building prices) OPA has announced a four-point program to continue all controls now possible within its present framework:

1. Rent controls will be relinquished in any rental area only when the danger of a general increase in that area has been eliminated—in other words, when the normal bargaining situation between landlord and tenant has been restored.

2. Control will be tightened sharply over building material prices, most of the fixtures required in a new home, and construction services. Regional and District OPA offices have been authorized to work out dollars and cents ceiling prices, varying from area to area, to reflect local cost situations. The new prices will be posted in building material stores, lumber yards, etc., just as the dollar-and-cent prices of food products are now posted in grocery stores.

"They will cover millwork items, bathtubs, septic tanks, wash basins and other items," Mr. Bowles explained. "There will also be ceilings for painting and papering, renewing a roof, for installing plumbing, digging cellars, and so on. These prices will take into consideration local wage rates. In addition to these new ceilings on materials and services, we are tightening controls over the margins which a contractor can add to the cost of a job. We intend to administer these controls vigorously, but none will be allowed to stand in the way of expanding production. We have, for example, granted price increases on brick, structural hollow tile, drain tile, gypsum lath and radiators."

3. Additional members of the OPA enforcement staff will be assigned to the building field.

4. Authority will be sought to control sales prices of housing. "Under the price control act," Administrator Bowles explains, "OPA has the power to control rents, the price of building materials, and the amount a contractor can charge for his services. We lack the power, however, to protect a prospective home owner from paying an inflated price for an old house or for a new house built by some development firm or speculator."

Mr. Bowles concludes his arguments for residential price control by pointing out that during and following the last war, the cost of building materials skyrocketed 218 percent. This, he contends, helped bring on a building slump which he hopes to avoid this time.

Labor Enigma

Every problem, it seems, must have its *X* quantity. In reconversion, the Unknown was the militance of labor's demands for higher pay. Industry's war record proved that it could produce under wartime conditions, at a pace nearly double that of peacetime. Logic argued that industry could do the same when it turned to civilian products. Surveys indicated the country had a backlog of demand sufficient to absorb much or all of such a production landslide. Accepted, too, was the assumption that labor would continue playing its same "produce more" role.

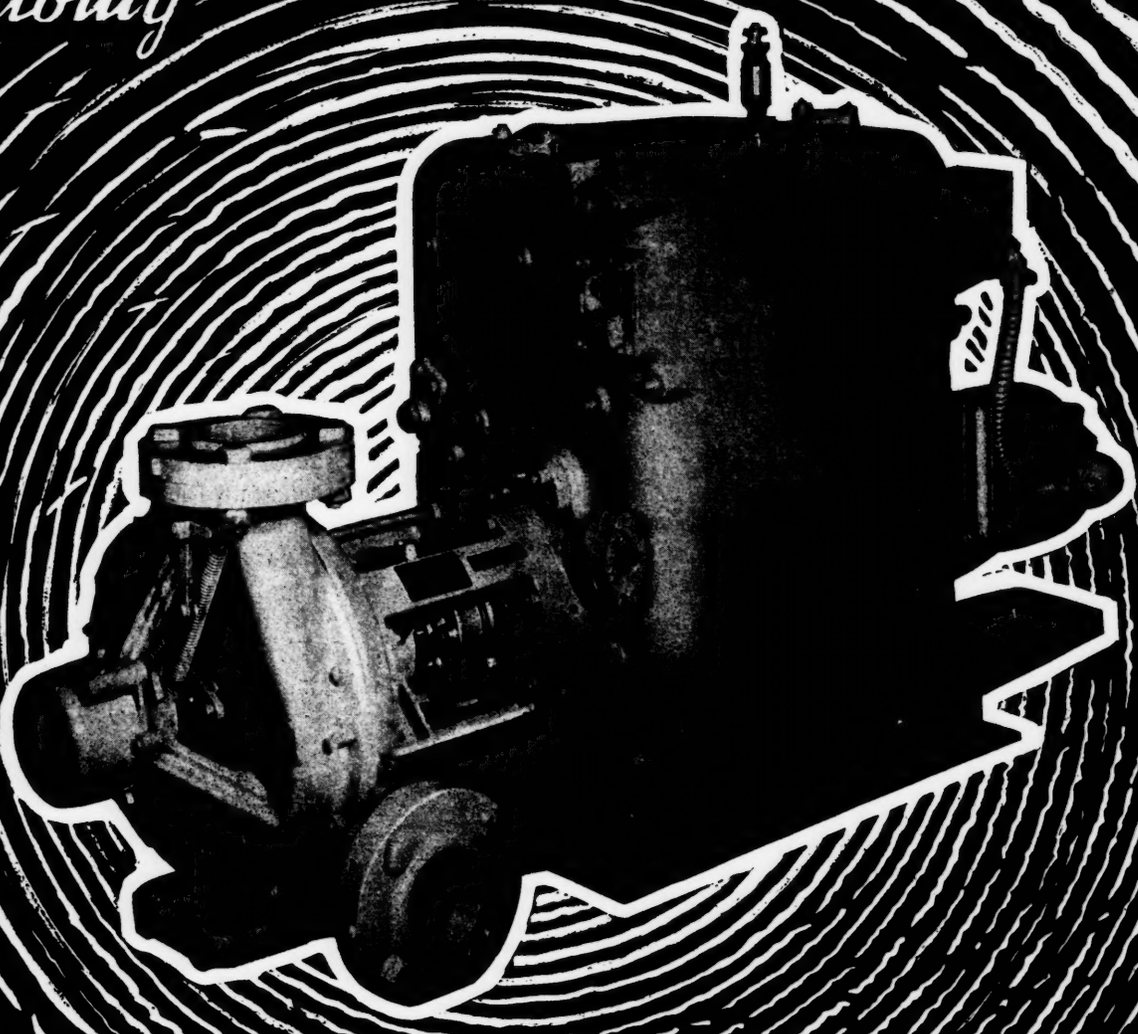
The major labor problem, many believed, would consist of absorbing those thrown out of work by war contract cancellations, and then making a place for the millions of returning servicemen. Then came the auto industry strike. The oil industry. The lumbering industry, and others. More than 350,000 idle by choice, at a time when the reconversion plan called for an all-out effort to get back into civilian production!

Current opinion in Washington is that a major battle is in prospect, with the present big company-big union outcome setting the stage for similar activities all the way down the line. Opinion seems divided as to whether former Economic Stabilizer Davis "spoke out of turn," or whether he merely "spoke out" when he outlined the Administration policy as favoring a 40 percent pay rise without an increase in prices. That Davis' assignment ended so shortly after his statement clouds the issue, but the demand of strikers for at least 30 percent higher wage rates persists.

In the meantime, strikes tie up a big segment of the auto industry, upon which one of out every seven persons depends, directly or indirectly, for his livelihood. And lumber strikes imperil the reconversion construction program. Strikers appear to be betting that industry, rather than see competitors move into the reconversion field ahead, will yield. Industry, which could probably ride out the storm for the few months that would be required for mass unemployment to develop and bring public opinion to their aid, hopes to work out the problem with fewer dramatics.

Probable, it is believed, is the conclusion that both sides will bow to the demands of the overall reconversion program and its importance to future prosperity. Likely is a compromise by both parties. Surely labor and management, working hand in hand for wartime victories, can compose their differences and work as closely for peace!

Centralized Heating Economy



A RETURN LINE VACUUM PUMP THAT CUTS HEATING COST.

This unusual pump needs no electric current, cutting out greatest item of pump operating expense.

More important, this pump insures absolutely uniform circulation in system. That means continuous steam economy.

Simple, compact, one moving element, no wearing parts, no internal lubrication. Bulletin No. 203 gives the facts. Your copy is waiting.

THE NASH ENGINEERING COMPANY
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HEATING AND VENTILATING

Baseboard Heating

SEVERAL forms of room units have been available to those designing steam or water heating systems for the home—radiators which emit heat by both radiation and convection, the true convector, and radiant panel heating. To these can now be added baseboard heating, at present used with forced circulation hot water systems.

Aside from whatever installation or operating economies may be claimed, this system has a marked appeal because it makes the heating element in the room practically invisible and thus permits wide latitude for the home decorator.

Instead of the conventional wood baseboard on the outer walls of a room, there is installed an assembly of hollow cast iron units made to resemble a baseboard, or a finned pipe placed near the floor line along the outer wall, and hidden by a metal enclosure to resemble a baseboard.

The latter, described in detail on page 76, is essentially an elongated convector made by Warren Webster & Co. Copper pipe with copper fins are so installed in a house as to provide a single loop that touches all outer walls. Temperatures on the ground floor are controlled by thermostats and temperature control by manual means is provided for bedrooms. For each bedroom there is a by-pass line and a valve. By closing the valve, the hot water flows through a by-pass line instead of the finned copper pipe. An outstanding feature is that the piping system from the boiler is greatly simplified and the customary feeders and returns for each radiator are eliminated.

Several companies are interested in the system of baseboard heating employing cast iron elements, including Burnham Boiler Co., and Crane Co. Many of the radiator manufacturers are interested and may announce designs of their own. Two models made by Burnham Boiler Co. are presented on page 78. One is essentially an elongated true radiator and consists of a hollow cast iron unit that resembles a baseboard. The other is a hollow cast iron convector with cast iron fins cast integrally with the unit. While at present used with hot water, both of the cast iron types may be later adapted to one-pipe steam systems.

The hollow cast iron baseboard was extensively tested in the I-B-R Research Home at the University of Illinois. Among the subjects studied (see page 80) were room temperature differential, operation with reduced air temperatures at night, and fuel consumption. The investigators concluded that by keeping the heat near the floor line, a low temperature differential resulted, and that there had been no discoloration of paint on the walls.

The three articles that follow present a complete summary of available information on baseboard heating.

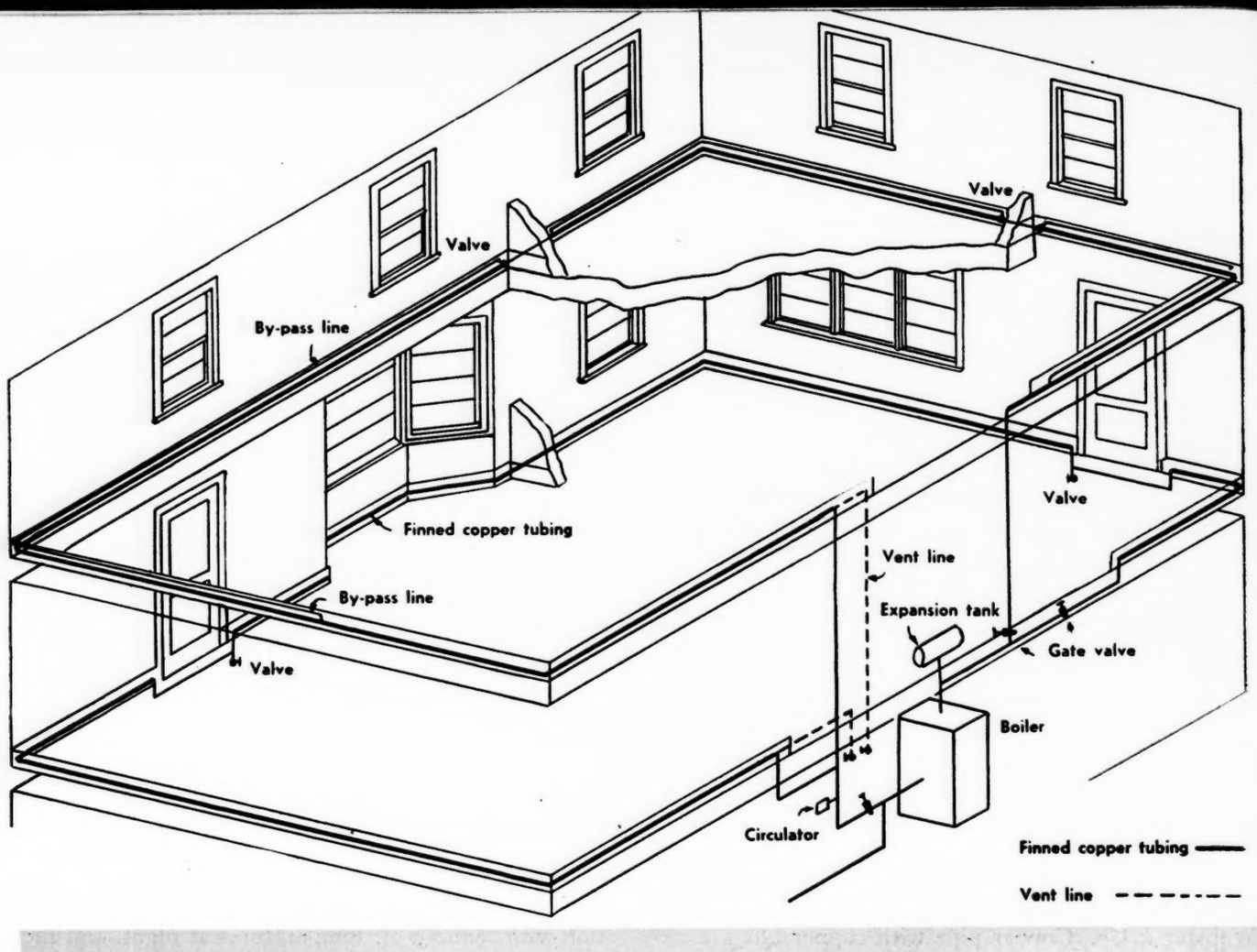


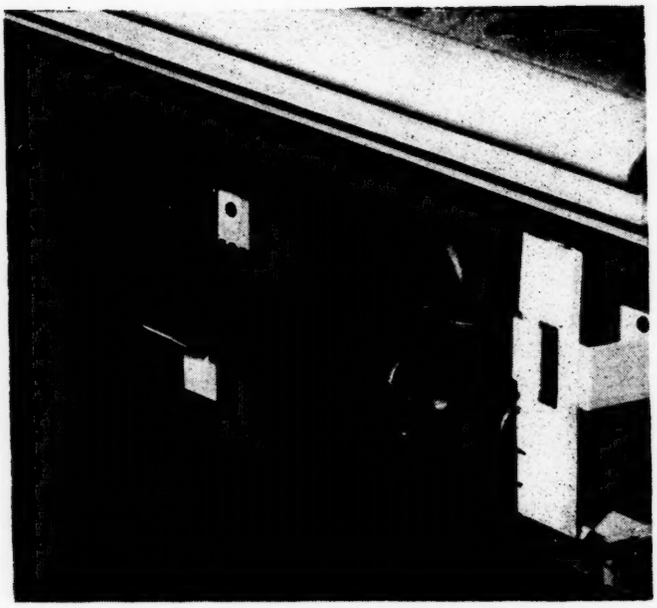
Fig. 1. Isometric view to show the simple piping system required, the placement of valves and vent lines, the by-pass lines for the bedroom floor and how the loop is carried under the doors.

Baseboard Heating— by Finned Copper Tubing

BASEBOARD heating for a forced circulation hot water system, as designed by Warren Webster & Co., Camden, N. J., is fundamentally an elongated convector running along the outside walls of the rooms in a house. It appears to have four outstanding features—simplicity of piping and therefore a saving in installation costs, a low temperature differential between the floor and ceiling in a room, a reduction in the visibility of the heating system, and the fact all walls of a room can be used by a home decorator.

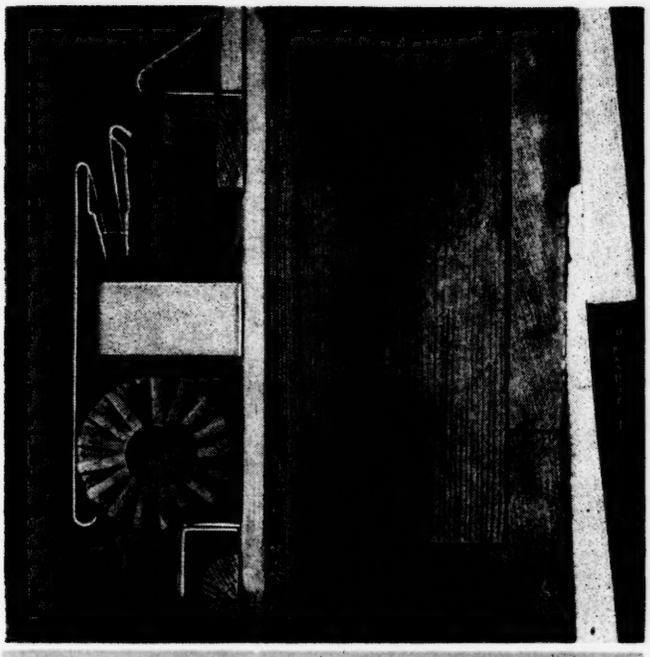
Each floor of a house is served by a complete loop of piping which starts with the riser from the boiler and ends with the return. The second floor of the house has a loop of its own, which will be described in more detail later, and is joined to the first loop to simplify the piping.

The heating element is a ¾ in. copper tubing with 2¼ in. diam. copper fins. It comes in standard length sections from 1 to 10 ft. The element for the standard system has 5 fins per inch and the low temperature system has 3 fins per inch. The company is now considering a high temperature system which will have a higher Btu output than either of these. The 5-fin system has a heat emission of 550 Btu per lineal



Details of by-pass line. The control valve handle projects through the baseboard that is mounted in front of the piping.

Photographs on front cover and page 75 show finished, residential, Warren Webster installations.



End view of a building wall to show construction details, and how the finned tube and heating element enclosure are supported.

foot with water at 200F, and at this temperature the 3-fin system an emission of 440 Btu per lineal foot.

The loop is placed adjacent to the outer walls where the baseboard would normally be installed. However, such rooms as the kitchen and bathroom often do not provide enough outside wall length, and it is necessary to install additional baseboard radiation on an inner wall. Where the second floor ceiling is insulated, the use of the 3-fin system is suggested for that floor.

To provide for a continuous loop, the finned copper pipe is carried along the floor up to a door, where it drops down to below the door by the use of pipe without fins, and then steps up to continue along where the baseboard should be on the outer wall. When the pipe is thus lowered because of doors, it is necessary to provide a valve that can be opened when draining the system.

The finned pipe, covered by a metal baseboard which resembles the customary wood baseboard, projects out from the plaster wall. The baseboard or heating element enclosure is about 5⅞ in. from bottom to top and is so mounted that there is a space of 1 3/16 in. from the bottom of the baseboard to the floor. There are also openings at the top, not easily observed, which provide for a continuous air current over the heated fins. However, the openings for the air currents were designed to prevent turbulence, which is considered the chief cause for markings on walls above conventional radiators. Air as it leaves the baseboard is at a low velocity.

Before mounting the baseboard, enclosure brackets, spaced 3 to 4 ft apart, are fixed against the studs or other solid part of the wall, by means of attachment screws. The metal enclosure clips over the enclosure brackets without the use of screws or other attachment means. Joints between sections of the enclosure, and also at doorways and partition, are covered with metal trim pieces.

The metal enclosure for the finned tube is furnished in 6 and 8 ft lengths. The last length for an enclosure assembly may have to be cut on the job to fit the room dimensions. However, the heating element is not cut; an uneven length can be made up with bare copper tubing. In other words, an assembly of standard lengths is used and is followed, if necessary, by a short length of bare copper tubing.

With this form of heating, the temperature differential between floor and ceiling, as found by test, is not over 2F. Temperatures are controlled by any of the conventional means such as room thermostats or outdoor temperature control.

Many persons like to reduce manually the temperature of the bedrooms as they prefer to sleep in a moderately heated room. Bedrooms, therefore, have a valved by-pass line so that by closing the valve, the finned tube line is closed, and the circulating hot water by-passed through a section of pipe as shown in Fig. 1.

The by-pass valve is placed directly in the heating element tube and the valve handle extends through the front of the baseboard.

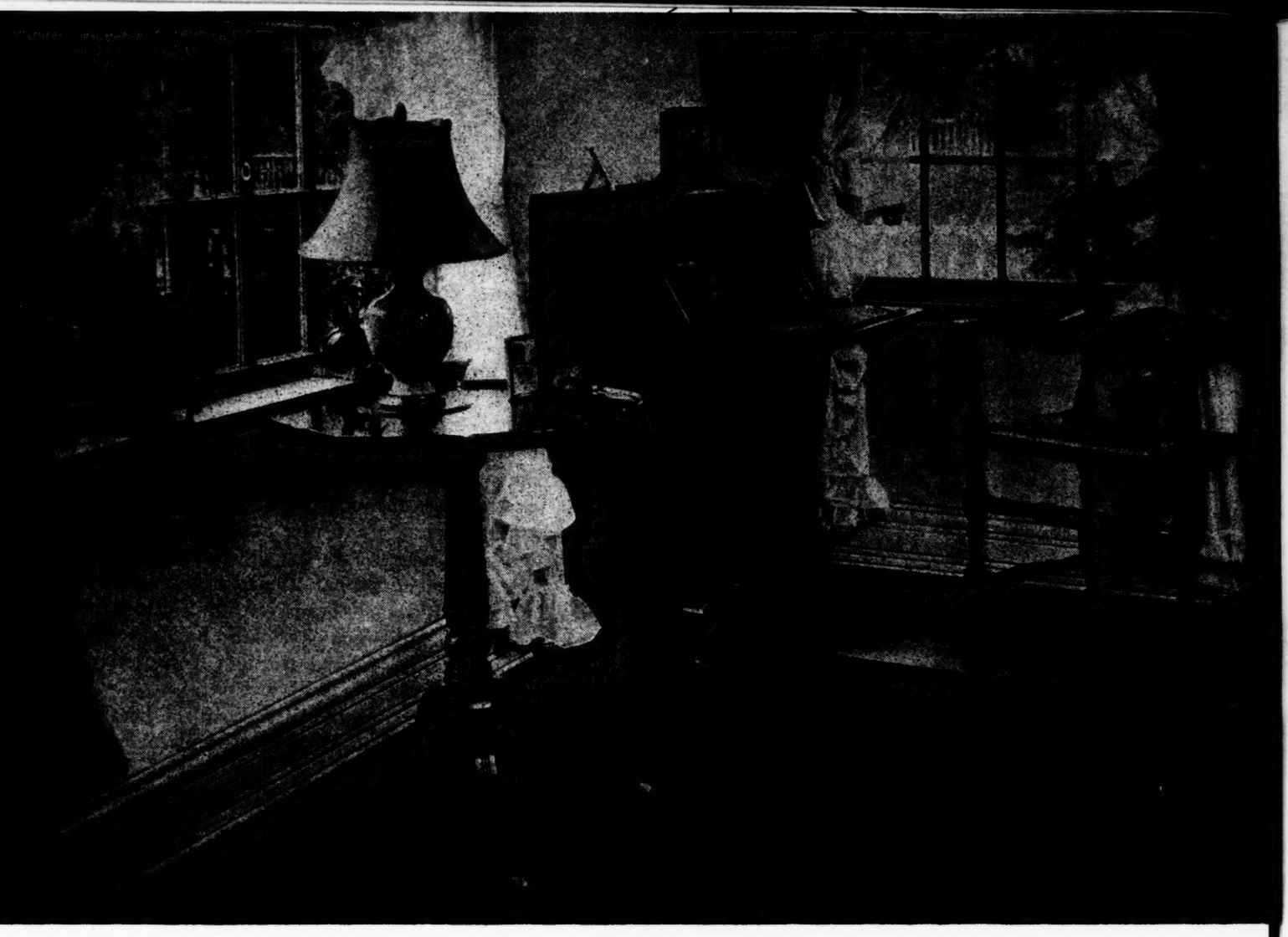
Vent lines with pet cocks should be extended to the basement for venting air from the system at start of each heating season.

An outstanding feature of this system is that the basement is freed from the maze of piping found in the home with the conventional hot water system served by radiators. Instead of two lines going to each of the hot water radiators, the only pipes from the basement to the upper floors are the supply riser and the return lines.

At present, this design is being used for a 4-apartment building, now being completed. One loop of pipe and a circulator are installed for each apartment.

The manufacturer believes that installation costs for jobs with this form of baseboard heating will run less than the system with the conventional radiators, and also says that a considerable saving will be shown in operation costs.

Detail of the baseboard design to show the corner strip, and the valve control protruding through the enclosure.



Baseboard heating facilitates home decorations. In this room, the control valve is in the valve box at the right end of the baseboard.

Baseboard Heating— by Cast Iron Sections

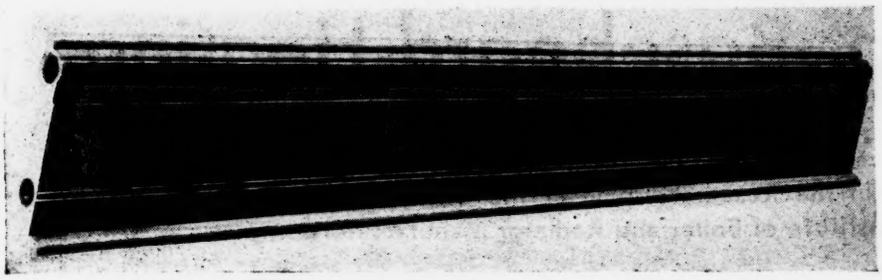
THE system of baseboard heating developed by Burnham Boiler Corp., Irvington, N. Y., is basically a hollow cast-iron baseboard or radiator through which the hot water flows. This form of radiation for a room is placed against the outer walls, and if conditions are such that added surface is necessary, they are also placed against an inner wall.

The baseboard, termed Base-Ray heat panel by the manufacturer, comes in 1 and 2 ft standard lengths, is 7 in. deep, and the thickness varies from 1¾ to 2 in. according to the model. In new buildings, this projection out into the room may be reduced to 1 in. by placing the baseboard in a recess provided in the walls.

Before going into the methods of installation, it may be well to differentiate between the two models available. The Standard model is a hollow cast-iron unit 7 in. deep and 1¾ in. thick, cast to resemble the regular type of wooden baseboard. The Hy-power unit has a series of integrally cast fins and a series of openings near the top, as illustrated. It is 2 in. thick. This type provides 60% more radiation than the Standard model and is used where heat emission in excess of the Standard model is required.

In both types, sections are joined by two push nipples and a short tie bolt. Where a wall length is such that it is a little greater than an assembly of standard units, the space not taken up by the baseboard panel is fitted with a piece of standard wood baseboard milled to resemble the cast-iron unit. Assemblies longer than 24 ft are not recommended by the manufacturer.

Supply and return connections are made in the same way as conventional radiators. In fact, the heating system may consist of both baseboard panels and the conventional type radiators. To determine the amount of radiation required, heat losses are calculated in the conventional manner, and then from standard tables supplied by the manufacturer, one obtains the lineal feet of baseboard radiation required for various average hot water temperatures. For example, with hot water at 190F, the average Btu output per hour for a 2 ft Hy-power section is



Front view of the Standard model showing provisions for joining the sections.

781. This becomes 870 and 1,000 Btu, respectively, for water temperatures of 200F and 215F. For the Standard model with a 2 ft panel and water at 190F, there is an output of 469 Btu per hour; this becomes 522 for water at 200F and 600 for 215F.

For each sq ft of radiation, the Standard model holds 22.8 ounces of water and the Hy-power, 13 oz. The conventional type of radiator, by comparison, holds from 15-17 oz water per sq ft of radiation, and the slenderized radiator 9 oz.

The Base-Ray baseboard is placed against the plastered wall or whatever wall surface is provided. The wall surface immediately back of the baseboard unit is faced with building paper from the floor to the top of the panels, and provisions made for a ½ in. lap of paper over the panel. A ½ in. quarter round moulding is placed on top of the lap, and in addition a ½ x ¾ in. wood mould or base-

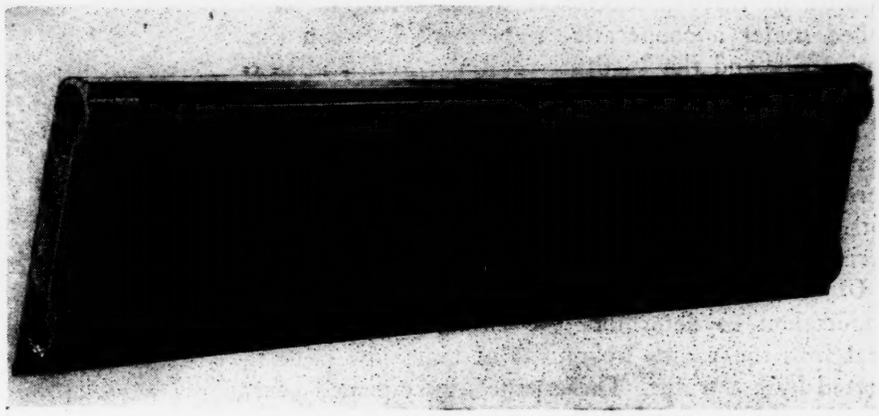
Front view of the Hy-power type.

board shoe is placed along the floor line of the Standard model. The paper seal and top moulding is to prevent streaking of walls or characteristic smudges above conventional radiators. However, tests have shown that there will be some wall streaking when the hot temperature exceeds 215F.

To cut fuel costs, the company recommends that insulation be installed in the space between studs of outside walls where the baseboard heating is to be placed. This insulation should be for a minimum height of 2 ft above the floor. When the Base-Ray unit is recessed into the wall, this insulation between the studding is essential.

As floors may be uneven, the sections are supported by small L-shaped brackets that permit a ⅜ in. vertical adjustment. The small space next to the floor is covered by the baseboard shoe.

When panels are installed on two adjoining walls, they may be connected in series by the use of a ¾ in. radiator union elbow and close nipple, or by ¾ in. sweat type copper fittings. These fittings provide some flexibility so that even though they are not at right angles to each other, distortion as much as 1 in. in 10 ft may be permitted with safety.

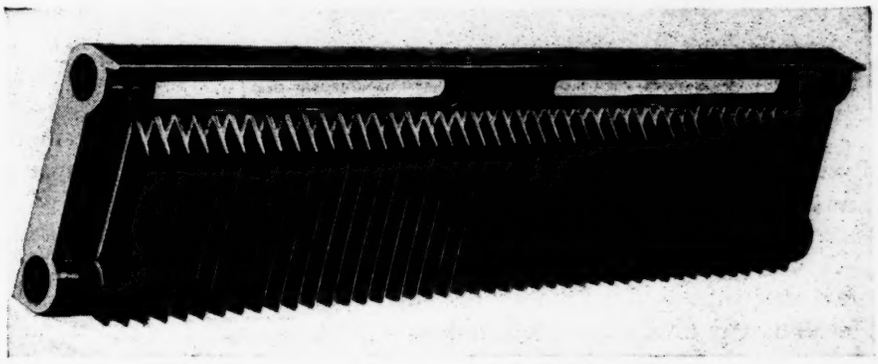


Rear view of the Standard model.

Each length of panels or series of panels, as in the case of a corner installation, is controlled by a valve which is placed in a valve enclosure bolted to the panel. Except for a slightly protruding cover-plate, the valve box resembles the baseboard. The valve enclosure is placed in an inconspicuous spot, generally at a corner of the room.

Baseboard panels will expand about ⅛ in. in 10 lineal feet for a temperature rise of 180F, and for that reason swing connections should be located in branches between the main and risers.

With this system, even when outside temperature is 0F, tests showed that the floor to ceiling temperature differential never exceeded 3F.



Rear view of the Hy-power type showing the cast iron fins.

I-B-R Tests of Baseboard Heating

Results of tests conducted on the cast-iron baseboard heating system in the Research Home at the University of Illinois for the Institute of Boiler and Radiator Manufacturers.

IN mid-September the Engineering Experiment Station of the University of Illinois released one of its highly informative series of bulletins on radiator heating entitled "A Study of Radiant Baseboard Heating in the I-B-R Research Home."[1] This report, by Professors A. P. Kratz and W. S. Harris, as with its three predecessors in the series, is published under a cooperative agreement between the University and the Institute of Boiler and Radiator Manufacturers.

This bulletin is particularly comprehensive on the temperature differentials and on wall surface temperatures obtained with cast iron baseboard radiators. Consequently, the following is abstracted by permission from the bulletin.

Objects of Investigation. The tests reported were undertaken to determine the effect of introducing heat into the rooms by means of long, low panels, heated by hot water. These panels were placed near the floor and extended along the exposed walls of the rooms. A second object was to compare the operating characteristics of the panels with the operating characteristics of conventional, small-tube radiators.

Description of Plant. The tests were carried on in the I-B-R Research Home, a two-story house in Urbana, of brick veneer with mineral wool insulation. The heating plant consisted of a wet-bottom, cast-iron boiler fired by a gas conversion burner

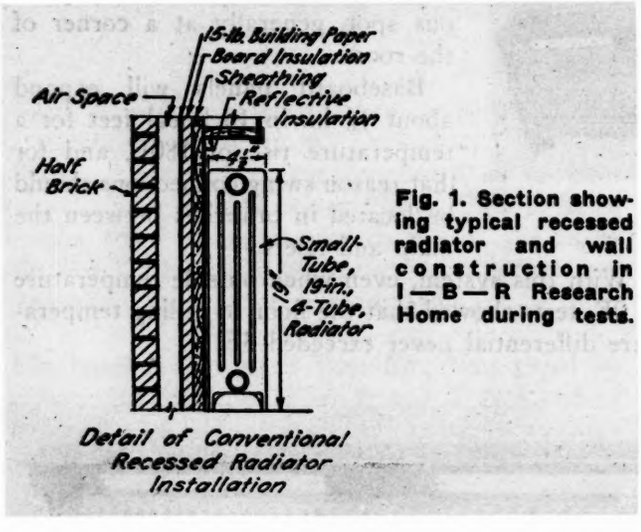


Fig. 1. Section showing typical recessed radiator and wall construction in I—B—R Research Home during tests.

burning 1000 Btu natural gas, and with the piping and heat emitting equipment arranged as described later.

A one-pipe, forced-circulation, hot-water system was used during the 1943-44 heating season. For the first part of the season, small-tube type, 19-in., 4-tube, cast-iron radiators (Fig. 1), set in open recesses below the windows, were used in all rooms of the house. For the remainder of the season the radiators in the living room, dining room, and all three bedrooms were replaced with wrought steel pipe extending along the exposed walls of the rooms near the floor. The steel pipe was used in place of

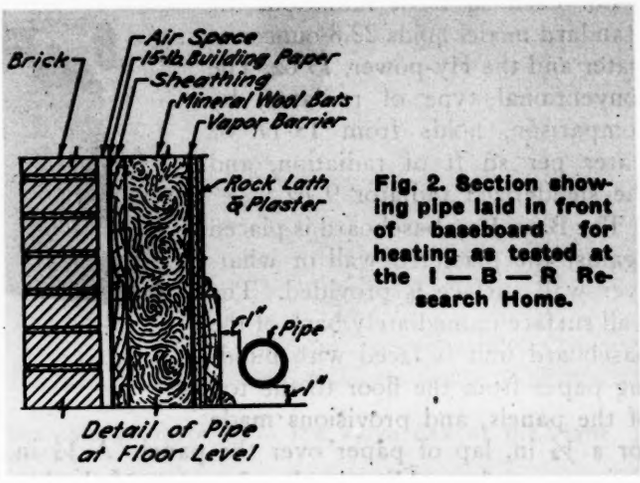


Fig. 2. Section showing pipe laid in front of baseboard for heating as tested at the I—B—R Research Home.

conventional radiation in order to obtain preliminary data on the effect of introducing heat into the rooms at the floor level without having to make up special radiator sections. However, it is quite conceivable that such pipes might be used as the radiator in the case of some of the low-cost housing, where it is essential to keep the first cost of the heating system to a minimum. The pipe is not too noticeable if it is painted to match the baseboard. See Fig. 2.

The sizes and lengths of the pipes were selected so that the total heat emission was equal to that from the conventional radiators which they replaced.

During the season of 1944-45 the radiators used in the living room, dining room, all three bedrooms, and the lavatory were of an experimental design made in the form of a hollow cast-iron baseboard approximately 6 in. high. These radiators, or "radiant baseboards", were installed along the outside walls of the rooms, replacing the wooden baseboard. A cross-section through the wall and radiator showing the method of installation is presented in Fig. 3. Rice paper served as a dust seal to prevent the possibility of streaking the walls. Small-tube type, 19-in., 4-tube, cast-iron radiators were used in the vestibule, the kitchen, the bath, and on the stair landing. The total heat emission from the radiators used in each room for the 1944-45 season was approximately the same as that used during the previous season. During the 1944-45 season the same

[1]Available from the University's Engineering Experiment Station, Urbana, Ill., price 35 cents.

boiler was used in connection with a two-pipe, reversed-return system. This system was designed to operate with a mean water temperature of 215F and a 30F drop through the radiators.

The same controls (thermostat, time switch, limit control, gas valve, safety pilot, transformer, and relay) were used in all tests.

Radiator Tests. Four series of tests were run, as follows:

(1) Tests designated as Series S, in which small-tube radiation was used in all rooms of the house,

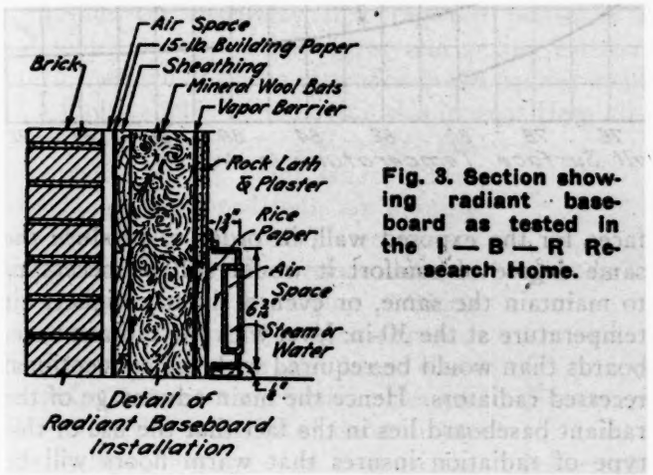


Fig. 3. Section showing radiant baseboard as tested in the I — B — R Research Home.

were conducted during the heating season 1943-44. The average temperature of the air in the rooms at the 30-in. level was maintained constant at approximately 72F both day and night. A forced-circulation system was used;

(2) Tests designated as series R, also conducted during the heating season of 1943-44, differed from series S only in that the small-tube radiation in the living room, dining room, and all three bedrooms was replaced with standard wrought-steel pipe extending along the outside walls of the rooms near the floor as shown in Fig. 2;

(3) Tests designated as series T, made on the same heating system as that used in series R, were conducted during the heating season of 1943-44. In this series the setting of the room thermostat was reduced to 66F at 10 p.m. and restored to 72F at 5:30 a.m.;

(4) Tests designated as series C-44, made on the two-pipe, gravity, hot-water system, were conducted during the heating season of 1944-45. The high-limit control was set to a temperature of 235F to make it possible to operate with an average radiator temperature of 215F, in case such a temperature should be demanded in sub-zero weather.

Results of Tests — Temperature Differentials. When changes were made for each series of tests, all of the radiators in the second-story bedrooms were replaced while some of those on the first story were left unchanged. Hence, it was considered that only the air temperature differentials observed in the second story should be used in making comparisons of the operating characteristics of the several types of radiators used, and therefore the discussion of results has been confined to data obtained in the three bedrooms. Data obtained in the first-story rooms showed characteristics similar to those obtained in the second-story rooms except that the floor to ceiling temperature difference was from 1F to 2F greater.

At an outdoor temperature of 0F, when the bedrooms were heated either by the pipe or by the radiant baseboards, the average floor to ceiling temperature difference was only about 2F, as compared with 5½F obtained when the rooms were heated by conventional recessed radiators. However, when either the pipe or the radiant baseboards were used, the temperature at the 60-in. level was the same as that 3 in. below the ceiling. Thus the entire temperature difference occurred within a zone extending from 3 in. above the floor to the 60-in level. At an outdoor temperature of 0F, the temperature 3 in. above the floor was 71.1F, the temperature at the 30-in. level was 72.0F, and the temperatures 60 in. above the floor and 3 in. below the ceiling were each 72.9F, while the corresponding temperatures for series S were 69.7F, 72.0F, 73.3F and 75.3F, respectively. Thus it may be observed that the use of either the pipe or the radiant baseboards resulted in a temperature, 3 in. above the floor, 1.4F higher than that obtained with the conventional recessed radiators. This difference between the temperatures at the 3-in. level increased as the outdoor temperature was decreased.

Even more striking evidence of the tendency of the radiant baseboard to produce warm air near the floor is presented in the case of the lavatory on the first story. The floor of this lavatory, which adjoined the unheated garage, was an extension of the concrete floor of the porch and was laid directly on the ground. Conditions in the lavatory, which proved extremely difficult to heat with a conventional recessed radiator, are typical of those encountered in certain types of basementless houses. At an outdoor temperature of 0F, and with the same temperature at the 30-in. level, the substitution of the radiant baseboard for the recessed radiator resulted in an increase of 6F in the temperature of the air 3 in. above the floor. Furthermore, with the radiant baseboard the temperature of the air at the 3-in. level was essentially the same as that at the 30-in. level.

A cold floor is a major factor in contributing to discomfort in otherwise well-heated rooms, hence the tendency to produce a warm floor may be regarded as an important attribute of radiant baseboards. This attribute is most important in the case of the basementless house in which cold floors are particularly prevalent. Therefore, the use of radiant baseboards is especially adaptable to this type of construction.

Wall Temperatures. Fig. 4 shows the wall surface temperatures, measured on the inside surface of the plaster on the north wall of the living room, resulting from the use of the conventional recessed radiators, the pipe at the floor level, and the radiant baseboards. At the times that these observations were made, the outdoor temperature was approximately 32F, and the temperature of the air in the living room at the 30-in. level was 74F. With the pipe at

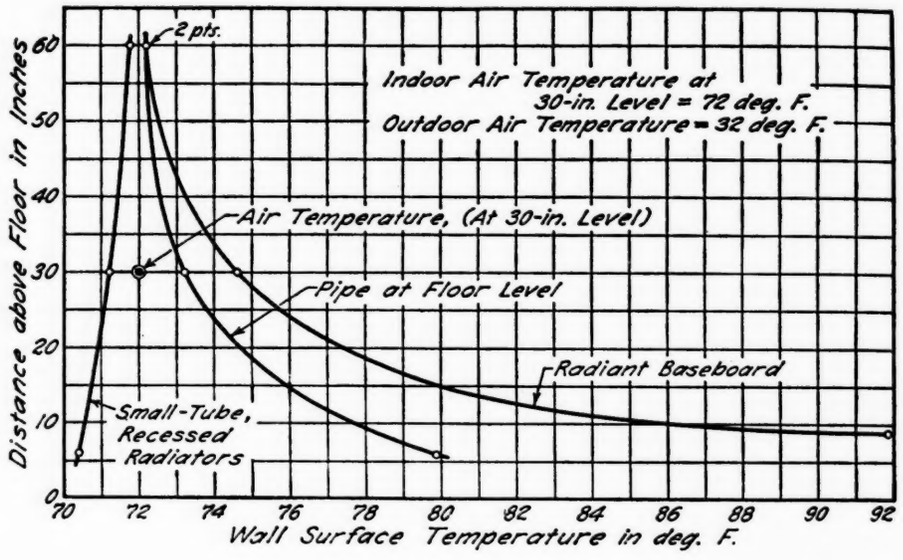


Fig. 4. Inside surface temperatures along the north wall of the I—B—R Research Home living room.

floor level, and with the radiant baseboard, the temperature of the entire wall below the 60-in. level was greater than the temperature of the room air at the 30-in. level, whereas with the conventional recessed radiator the temperature of this portion of the wall surface was from 0.2 to 1.6F below the temperature of the air at the 30-in. level. Thus, up to a height of 60 in., both the pipe at the floor level and the radiant baseboard warmed the entire surface of the portion of the exposed wall along which they were installed.

On the other hand, with the conventional recessed radiator, only the small portion of the wall forming the back of the recess was warmed, and this contributed nothing to comfort because this portion of the wall was hidden by the radiator, which was at a much higher temperature. The radiant baseboard was installed so that in effect it formed part of the wall itself. In this case the warming effect was the greatest because the wall was heated by conduction up through the plaster.

If all other factors except the wall surface temperature remained unchanged, the increase in the wall surface temperatures accompanied by the use of the floor level pipe and the radiant baseboard would result in an increase in the mean radiant temperature in the room. However, measurements made at the 30-in. level by means of both a thermo-integrator and a globe thermometer in five different locations in the living room proved that with conventional recessed radiators the mean radiant temperature was about 1F higher than the air temperature, and with the floor level pipe and radiant baseboards the mean radiant temperature was from 0.5 to 1.0F lower than the air temperature.

This condition is just the reverse of that to be expected from the wall surface temperatures obtained with the three types of radiation. The higher mean radiant temperature obtained with the conventional recessed radiators must have been the result of the higher ceiling temperature accompanying the use of these radiators. These mean radiant temperature observations indicate that, in an insulated house, even though the use of radiant baseboards results in warmer air near the floor and in warmer inside surfaces for the exposed wall, in order to produce the same degree of comfort it would still be necessary to maintain the same, or even a slightly higher, air temperature at the 30-in. level with the radiant baseboards than would be required with the conventional recessed radiators. Hence the main advantage of the radiant baseboard lies in the fact that the use of this type of radiation insures that warm floors will be obtained.

During part of each heating season the thermostat setting was reduced at night both when operating with the conventional recessed radiators and with the pipe at the floor level. In general, the performance obtained with the pipe did not differ materially from that obtained with the conventional recessed radiators. However, in the case of the pipe, the overruns in the temperature of the air 3 in. below the ceiling during the morning warming-up cycle were somewhat less than those obtained with the conventional recessed radiators. Data obtained for the radiant baseboards were incomplete, but indicated that the performance with these baseboards was essentially the same as that obtained with the pipe at the floor level.

Fuel Consumption. The investigators found no material difference in fuel consumption among the three types of radiators.

Cleanliness. Immediately after installing the radiant baseboards and before any heat was required, all the walls were freshly painted and all curtains and draperies were cleaned. After operating through a complete heating season of approximately nine months no dirt patterns were observed on the walls above the radiant baseboards and there was no evidence that the heat had discolored the paint on the wall. Furthermore, at the end of the heating season, the white curtains at the windows over the radiant baseboards were as clean as were similar curtains at windows under which no radiators were located. Neither were in need of cleaning. On the other hand, characteristic dirt patterns appeared on the walls above the conventional recessed radiators on the stair landing and in the kitchen and the curtains above these radiators were in need of cleaning long before the end of the heating season.

Determining Pollen Arrestance of Air Filters

J. R. HUGHES

Chief Chemist, Works Laboratory, Owens-Corning Fiberglas Corporation, Newark, Ohio

SINCE the discovery that ragweed pollen is a major source of hay fever and pollen asthma, much research has been expended in the development of a filter capable of removing this irritant from air-conditioned atmospheres. Research has progressed to the point where offices and homes equipped with air filtering devices now offer pollen-free air to the personnel. This development has generally resulted in higher working efficiencies in the area since personal discomforts have largely been eliminated during the pollen season. However, the problem of determining the actual efficiency of a filter in the removal of air-borne pollen was encountered.

In the past, filters and installations were checked for efficiency during the relatively short period from the middle of August until the first killing frost. During this period, the natural supply of pollen is unlimited and is readily available for testing purposes. However, there are definite disadvantages prevalent during the pollen season for the actual pollen content of the atmosphere varies greatly from day to day, depending on climatic conditions. See Table 1. Rain decreases the pollen concentration sharply, while clear weather and slight breezes tend to increase it. Secondly, any development or improvement in filtering devices to be evaluated must of necessity wait for the pollen season.

Test Equipment

A diagram of the testing apparatus is shown in Fig. 1. This filter testing machine conforms essentially to that described in the ASHVE Standard Code for Testing and Rating Air Cleaning Devices Used in General Ventilation Work. For our testing, a plenum chamber of 2000 cu ft capacity was added to the aforementioned equipment. This contributed materially in obtaining an even pollen distribution during the tests. See Fig. 2.

The pollen feeding apparatus, as shown in Fig. 3, consists of a turntable activated by a gear head motor. As the turntable revolves, it also moves to the right, thus enabling the aspirator to pick up and inject a continuous supply of pollen.

The plenum chamber was constructed from ¼ in. plywood with the studding on the outside. This presented a smooth surface inside the room and minimized pollen losses through settling on the walls. Chamber capacity of 2000 cu ft was chosen in order that the air would not be changed more rapidly than the time required for even pollen dispersion. Our tests were mainly conducted at 800 cfm which allowed an air change in the plenum chamber once each 2.5 minutes.

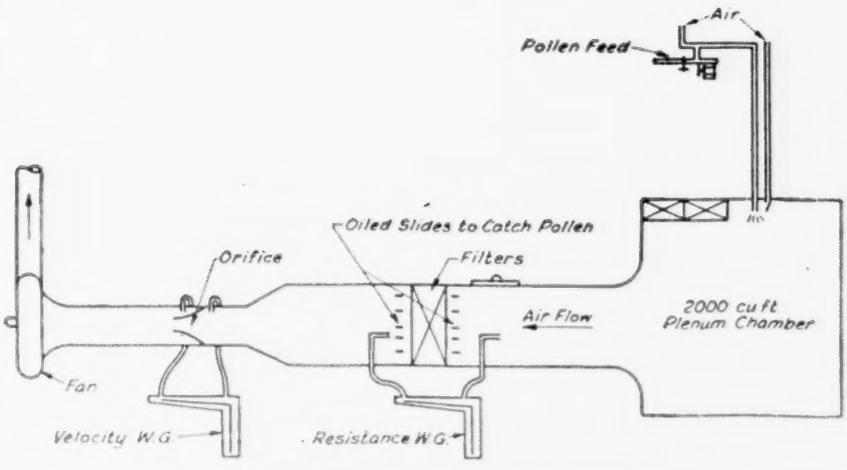


Fig. 1. Diagram of testing apparatus.

Test Procedure

Pure giant ragweed pollen was purchased for the series of tests. Unit test cost is about $0.10, since one gram is required for each efficiency determination.

The filter to be tested is positioned and sealed by taping the edges to the duct. This prevents leakage. Exactly one gram of pollen is spread evenly on the turntable disc to be picked up and ejected into the plenum chamber by an aspirator. After the pollen enters the chamber, it is agitated violently by a 24 in. propeller type fan and two jets of compressed air. More pollen than is actually needed is introduced into the plenum chamber to take care of any losses incurred by settling and impingement. It was the general practice to charge the plenum chamber from two to five minutes before starting the test, so as to build up a sufficient pollen concentration. The test is then started and continued for fifteen minutes.

To check filter efficiency, glass microscope slides are coated evenly with a thin film of petroleum jelly and are placed in the duct. Usually four or five slides are placed on each side of the filter to give

TABLE 1.—RAGWEED POLLEN RECORD FOR OKLAHOMA CITY—1926*

A study of the effects of precipitation, sunshine and wind velocity on the pollen content of the air.

Date	Pollen Count	Precipitation, Inches	% Sunshine	Wind Velocity, Mph
Aug. 30	1000	0.38	38	7.1
31	6000	0	87	13.9
Sept. 1	6200	0	84	15.0
2	6900	0	96	14.4
3	5000	3.16	57	14.8
4	2600	0.03	50	11.5
5	1500	0.70	55	5.1
6	3000	0	100	5.2
7	4700	0	96	11.4
8	5800	0	68	14.0
9	4900	0.48	52	10.3
10	2600	0	45	5.8
11	3400	0	98	14.2
12	5200	0	65	12.0
13	4000	0	69	6.4
14	3800	0	94	12.4
15	6200	0	98	11.9
16	6800	0	99	11.8
17	7000	0	89	11.2
18	6000	0	100	8.7
19	4400	0	100	6.0
20	3700	0	100	4.8
21	3200	0	100	7.7
22	3000	0	100	7.0
23	4600	0	100	14.0
24	4400	.2	73	13.5
25	2200	.66	14	17.2
26	800	.10	0	6.7
27	500	.58	0	5.2
28	400	1.53	0	6.1
29	200	1.2	3	6.6
30	1000	0	57	15.0
Oct. 1	1200	0	86	13.5

*Extracted from data found in "Factors Which Determine the Pollen Content of the Air," by Ray M. Balyeat, *Journal of Laboratory and Clinical Medicine*, Volume 12, Page 1151.

a representative coverage of the total area. After the test is terminated, the slides are carefully removed from the test duct, and are placed in properly identified two-ounce bottles with tightly fitted caps.

Each slide is placed under a microscope fitted with a 10X ocular and a 10 mm. objective. This magnification was determined as most suitable for this work since the pollen grains were easily counted. Pollen can easily be identified from dust particles for the grain appears spherical in shape with exfoliations and the surface is pock-marked in a grid design. Although errors due to mistaking dust particles for

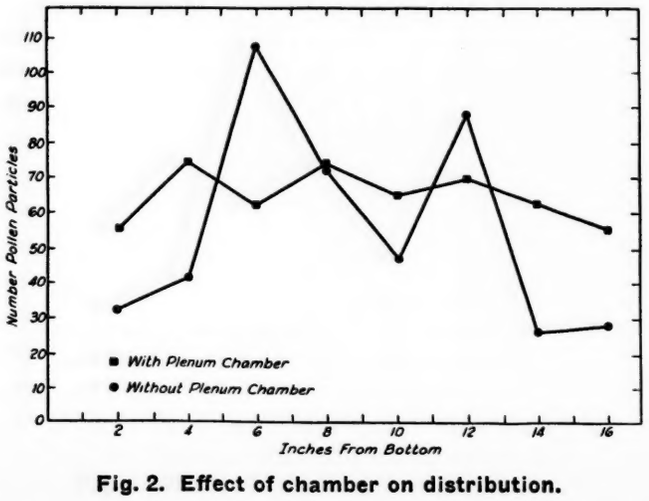


Fig. 2. Effect of chamber on distribution.

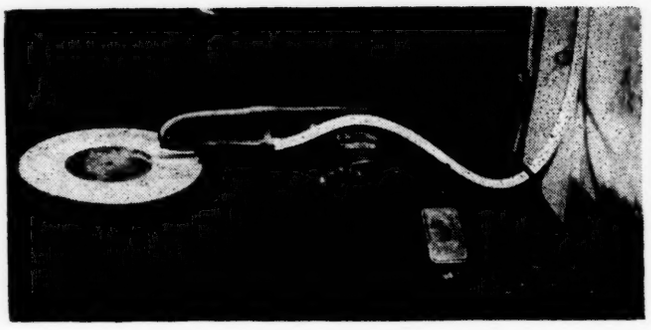


Fig. 3. Pollen feeding apparatus.

pollen are evidenced, these are negligible after sufficient practice is achieved.

Five strips the width of the microscope field taken across the lesser dimension of the slide are scanned and tabulated. The total pollen counts on the intake side of the filter and those on the exhaust side are used in computing the filtering efficiency. In most cases, check tests are made on the same filter. Table 2 gives the data obtained from typical tests conducted according to the proposed procedure.

TABLE 2.—COMPARISON OF EFFICIENCY RESULTS DURING CONSECUTIVE TESTS ON THE SAME SPECIMEN FILTER.

Specimen—Dust-Stop Air Filter—20 in. × 20 in. × 2 in.
Velocity = 400 fpm. Resistance = 0.15 in. W.G.

Test Number	Intake Pollen Concentration	Exhaust Pollen Concentration	Efficiency, %
1	2631	75	97.2
2	2772	72	97.4
3	2402	79	96.7
4	2605	81	96.9
5	2476	60	97.6
6	2510	73	97.1
			Average 97.15

Conclusions

The test procedure described has many obvious advantages over the previously employed methods.

It is entirely independent of a natural source of pollen laden air.

The air velocity passing through the filter can be accurately regulated and filtering efficiencies can be determined at any desired face velocity. This is important since the volume of air handled varies with each installation.

The pollen concentration can be altered at will to give any predetermined value.

The test is rapid and uncomplicated.

A complete standard size filter can be evaluated in preference to a special size or segment of a filter.

Results agree within ± 0.5% in nearly all cases, thereby adding accuracy of data to the aforementioned characteristics.

The author wishes to express his gratitude to Professor Philip Drinker of the Harvard School of Public Health and to P. N. Dangel of Children's Hospital, Boston, Mass., for their valuable advice in overcoming many of the problems encountered in the development of this test procedure.

Note.—A bibliography of articles relating to pollen and air filtration is available.

Applications of Fluid Flow

J. M. Dalla Valle

HEATING AND VENTILATING'S REFERENCE SECTION

Applications of Fluid Flow

J. M. DALLA VALLE

In the April issue Mr. Dalla Valle presented, under the title "Fundamentals of Fluid Flow", a summary of basic data and formulas on fluid flow, accompanied by text explaining the derivation of the data, insofar as this is of concern to most practicing engineers. The section which follows is the concluding part of the original manuscript on fluid flow; this second and concluding section covers, in general, applications to practical problems of the data presented in the first part.

FLOW OF STEAM

EQUATION (17)* is perfectly general and may be applied to any fluid, provided the relation between the friction factor f and Reynolds' number R_e is known. We have given an equation for f in the case of steam (Equation 22), so that when R_e is known the pressure drop is completely solved. Unfortunately, in actual systems as installed there is some condensation within the pipe and f may vary over wide limits. Special formulas have been developed which are extensively used, and within certain limitations they give us the information desired quite accurately. One of these is the Babcock formula

$$\frac{P}{l} = 175\left[0.0027\left(1+\frac{3.6}{D}\right)\right] w^2 D^{-5} V \ldots\ldots (39)$$

where P/l is the pressure drop in pounds per square inch per foot of pipe, D the pipe diameter in inches, w the rate of flow in pounds per second, and V the average specific volume in cubic feet per pound. This formula is accurate when the pressure is not very large.

While much has been written regarding the flow of steam in pipes, applications of many carefully made observations are vitiated in practical instances because we cannot foretell precisely what is happening. The question of heat losses, wetness of steam, and conditions of the pipe are extremely difficult to determine.

If we wish to utilize Lander's equation for f, which applies to clean, well-lagged pipes, we may use the extensive data of Hawkins, Solberg and Potter for n in calculating R_e. The data are given in Table 5.

Velocities for saturated and superheated steam range from 4000 to as high as 20,000 ft per min. Velocities above 8000 ft per min are used for superheated steam, at pressures above 200 lb per sq in. Note that in Equation (39) when D is large the term in parentheses is very nearly D^{-5}. Note also that in using Equations (17) and (22) p' is the reciprocal of the specific volume usually given in steam tables.

The factor $0.0027\ (1 - 3.6/D) = f$ in Equation (39) is a friction factor. For high pressures this factor is related to w and is expressed as

$$f = 0.0072\ (w)^{-1/4}$$

TABLE 5.—VALUES OF n FOR STEAM*

Temperature (deg F)	Pressure (absolute, lb per sq inch)						
	14.7	100	200	300	400	500	600
	Values of n Centipoises						
300	.0155						
400	.0172	.0186	.0220				
500	.0190	.0202	.0212	.0223	.0230	.0243	.0252
600	.0209	.0220	.0228	.0238	.0246	.0251	.0261
700	.0226	.0237	.0243	.0250	.0258	.0265	.0270
800	.0246	.0255	.0260	.0264	.0272	.0277	.0284
900	.0263	.0269	.0273	.0280	.0286	.0290	.0295
1000	.0281	.0283	.0289	.0294	.0300	.0283	.0288

*To convert the values in this table to ft per sec-units multiply by 0.000762.

so that Equation (39) may be written

$$\frac{P}{l} = 1.2\ w^{1.9/4}\ V\ D^{-5} \ldots\ldots (40)$$

Example. Compare Equation (40) with Equation (17) using Lander's Equation (22) for the following condition: w = 1.0 lb per sec, D = 4 inches, l = 1000 ft, t = 500F, and boiler gauge pressure = 485.3 lb per sq in.

(1) Pressure of 485.3 lb per sq in gauge = 500 lb per sq in. abs:

V (from steam tables) = 0.993 cu ft per lb at 500F.

Hence from Equation (40)

$$P = 1.2 \times (1)^{1.9/4} \times 0.993 \times 4^{-5} \times 1000$$
$$= 1.2 \times 1 \times 0.993 \times 0.00098 \times 1000 = 1.17 \text{ lb per sq inch.}$$

(2) With 1 lb flowing per second at 0.993 cu ft per lb and with a 4 inch pipe, the velocity would be

$$\frac{0.993 \times 1}{\left(4^2 \times \frac{\pi}{4}\right) \div 144} = \frac{144 \times .993}{4\pi} = 11.4 \text{ ft per sec.}$$

n for steam at 500 lb (from Table 5)
$= 0.0243 \times .000762 = 18.5 \times 10^{-6}$

From Equation (7) $R_e = \dfrac{p'vd}{n}$, and $p' = \dfrac{1}{.993} = 1.01$, so that

$$R_e = \frac{1.01 \times 11.4 \times 4}{12 \times 18.5 \times 10^{-6}} = 2.1 \times 10^{6}$$

Lander's Equation (22) is

*Equation (17), used in the April article, shows that the pressure drop per unit length of pipe (p/l) may be expressed in the following manner:

$$\frac{p}{l} = f \cdot \frac{1}{d} \cdot \frac{p'v^2}{2g} \ldots\ldots (17)$$

where f is a "wall" or "roughness" factor which accounts for the effect of the pipe surface on flow; p', the density of the fluid; v, velocity; d, diameter of pipe; g, acceleration due to gravity.

$$f = 0.016 + \frac{1.128}{R_e^{0.44}}, \text{ so that}$$

$$f = 0.016 + \frac{1.128}{(2.1 \times 10^5)^{0.44}}$$

$$f = 0.016 + \frac{1.128}{215} = 0.005$$

Using Equation (17)

$$\frac{p}{l} = f \cdot \frac{1}{d} \cdot \frac{p'v^2}{2g}$$

$$p = .021 \times \frac{12}{4} \times \frac{1.01 \times (11.4 \times 11.4)}{64.4} \times 1000$$

p = 129 lb per sq ft = .89 lb per sq in. drop.

Thus, while the values of (1) and (2) compare favorably, the result obtained by Lander's equation is higher than the other.

FLOW OF GASES

As long as fluids are regarded as incompressible the equations given in the preceding paragraphs hold. This condition is covered by the statement that the pressure drop is small in relation to the pressure applied. When the pressure drop is large relative to the applied pressure, there is a change in the volume of fluid flowing as covered in the introductory remarks on gas laws. Let us begin with Equation (17), writing it in the following form

$$dP = f \cdot \frac{1}{d} \cdot \frac{v^2}{2gV} \cdot dl \quad \ldots (41)$$

where dP denotes the pressure drop over an infinitesimal length of pipe dl, and V is the specific volume or volume of gas per unit weight of gas $\left(= \frac{1}{p'}\right)$

But from the gas laws

$$PV = BT \quad \ldots (42)$$

where B is the gas constant = 53.3 in FPS-units, and T the absolute temperature, so that $V = BT/P$. Substituting V from this equation in Equation (41)

$$dP = f \cdot \frac{1}{d} \cdot \frac{v^2P}{2gBT} \cdot dl$$

We have also that the weight of gas flowing per second is

$$w = \frac{vA}{V} = \frac{vAP}{BT}$$

or

$$v = \frac{wBT}{AP}$$

so that

$$dP = f \cdot \frac{1}{d} \cdot \frac{w^2BT}{2gPA^2} \cdot dl$$

Integrating between the limits p_2 and p_1, the terminal pressures in the distance l,

$$P_1^2 - P_2^2 = f \cdot \frac{1}{d} \cdot \frac{w^2BT}{gA^2} \cdot l \quad \ldots (43)$$

which is a special form of Babcock's formula. Equation (39). Taking a value of B = 53.3 (air), converting A and d to inches, P to pounds per square inch, and taking T as 460 + 60 = 520F, the absolute temperature at 60F

$$P_1^2 - P_2^2 = 16800\, f_{60} \cdot d^{-5} \cdot w^2 \cdot l$$

If we take an average value of $f = 0.03$

$$P_1^2 - P_2^2 = 504\, d^{-5} \cdot w^2 \cdot l \quad \ldots (44)$$

a formula widely used in practice, and where P_1 and P_2 are the pressures in pounds per square inch at a distance l feet apart, and w is the flow of air in pounds per second.

Example. Derive an equation in engineering units for

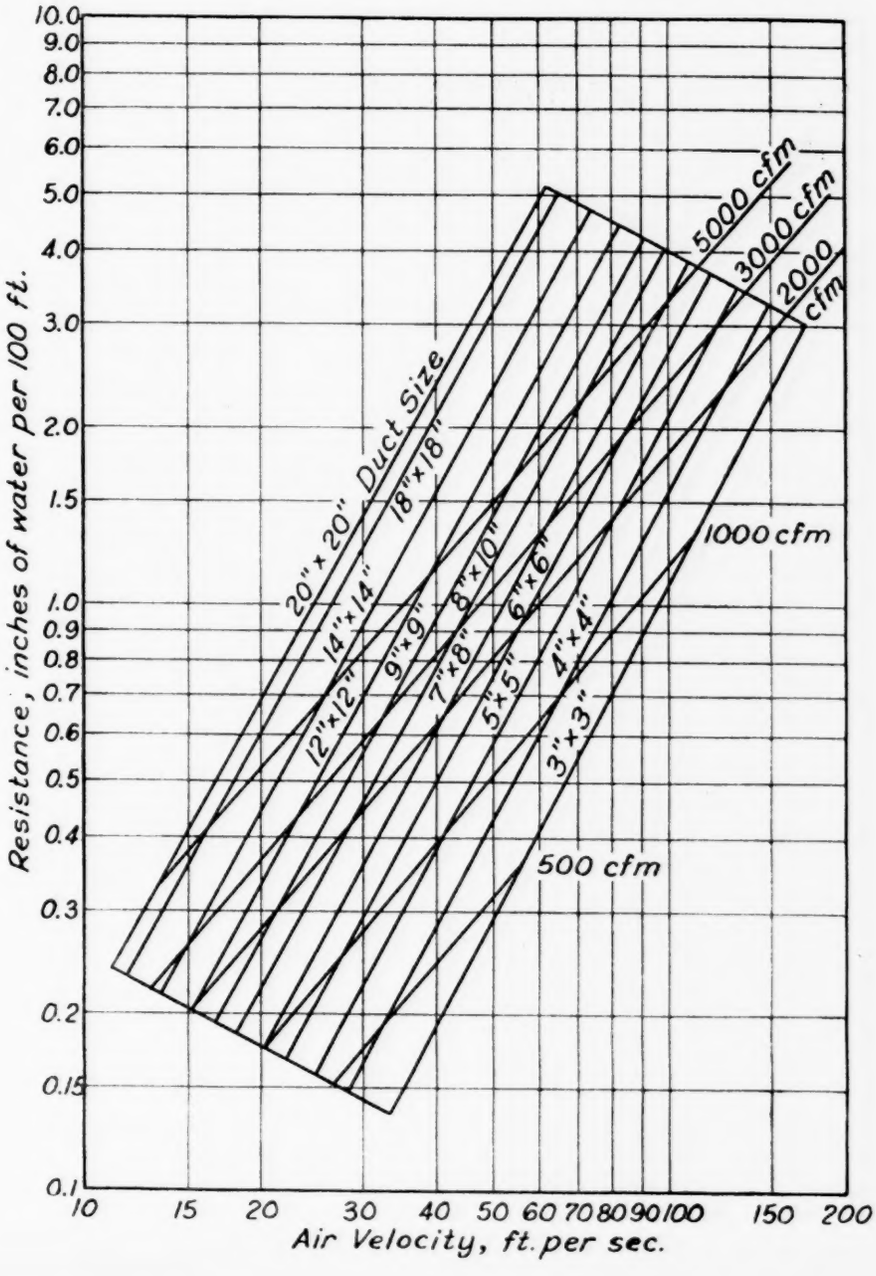


Fig. 13. Author's equation (48) plotted to show resistance losses in square ducts.

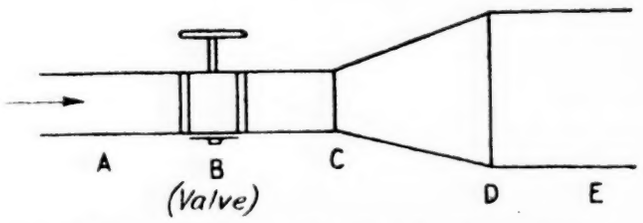


Fig. 14. Representative pipe line for demonstration of Bernouilli's theorem.

the flow of air in a pipe when the pressure drop is small. Use a value of f = 0.03.

$$1.\quad P = 0.03 \cdot \frac{1}{d} \cdot \frac{p'v^2}{2g} \cdot l$$

If D is the diameter in inches and $v = V/A = 4 \times 144 \times V/\pi D^2$, then P in pounds per square inch is

$$P = \frac{0.03}{144} \times \frac{12}{D} \times \frac{p'V^2}{2g} \times \left(\frac{4 \times 4 \times 144 \times 144}{\pi^2 D^4}\right) \times l$$

$$P = 1.08\ p'\ V^2\ D^{-5}\ l$$

When V is expressed in cubic feet per minute, V_c

$$P = 0.0003\ p'\ V_c^2\ D^{-5}\ l$$

LOSS IN RECTANGULAR DUCTS

Rectangular ducts are used almost exclusively for ventilation systems. Although they represent an important aspect of design work, experimental evidence of losses incurred when air is flowing through them is scarce. Great reliance has been placed on conversion formulas expressing the duct dimensions in terms of an equivalent diameter. Thus, if $\bar{R}$ represents the hydraulic radius (duct area ÷ duct perimeter), for circular ducts we have

$$\bar{R} = \frac{\pi d^2}{4\pi d} = \frac{d}{4}$$

and for a rectangular duct with sides a and b

$$\bar{R} = \frac{ab}{2(a+b)} \qquad \text{.....(45)}$$

Equating the two terms for $\bar{R}$ we assume that we have two hydraulically similar ducts, that is

$$d_e = \frac{2ab}{a+b} \qquad \text{.....(46)}$$

where d_e is written for the equivalent diameter of a rectangular duct. For a square duct (where a = b)

$$d_e = \frac{2a(a)}{a+a} = a \qquad \text{.....(47)}$$

or the equivalent diameter of a square duct is equal to the side of a square.

The author has endeavored to compile available data on the resistance losses in square ducts, and derived the following formula in the case of air flow

$$h_{100} = 6.0 \times 10^{-5}\ L^{1.15}\ v^{1.85} \qquad \text{.....(48)}$$

where h_{100} is the loss in pressure per 100 ft of duct in inches of water, L the length of the side of the square in inches, and v is the velocity of the air in feet per second. The data represented by this equation are shown plotted in Fig. 13.

BERNOUILLI'S THEOREM

By the principle of conservation of energy the total energy at any point in a pipe system must equal that at any other point when all transformations of flow and losses are accounted for. There are three kinds of energy to account for—potential, kinetic, and energy lost by one means or another. Consider any pipe line such as in Fig. 14.

Let us determine the energy relationships involved in the section AE. At A, the flow having a velocity v_a, the kinetic energy is $v_a^2/2g$. The pressure, by virtue of which the fluid flows, is P_a at the same point. Now, according to Bernouilli's theorem the sum of these two energies must be equal to that at any other point, say E, plus the energy losses incurred between the points. Thus

$v_a^2/2g + P_a/p' = v_e^2/2g + P_e/p'$ + loss in friction AB + loss in valve B + loss in friction BC + loss at enlargement CD + loss in friction DE

where p' is the density of the fluid and the P's must be converted to fluid height. We have already dealt with the friction losses and these are readily computed. Losses incurred through valves, enlargements, or other connections such as elbows, tees, etc., are more difficult to determine. Losses in energy due to these obstructions are commonly referred to as "shock" losses. For several

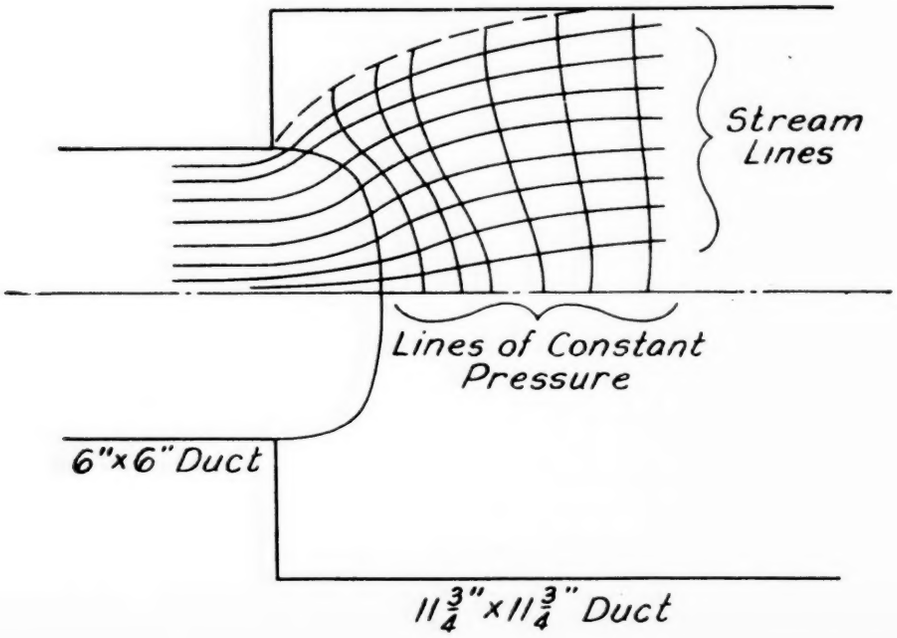


Fig. 15. Streamlines in enlargement of square duct based on data on air flow published by University of Illinois. Region of discontinuity shown by dotted line is estimated. So far as is known, no similar data exist for other sections or fluids.

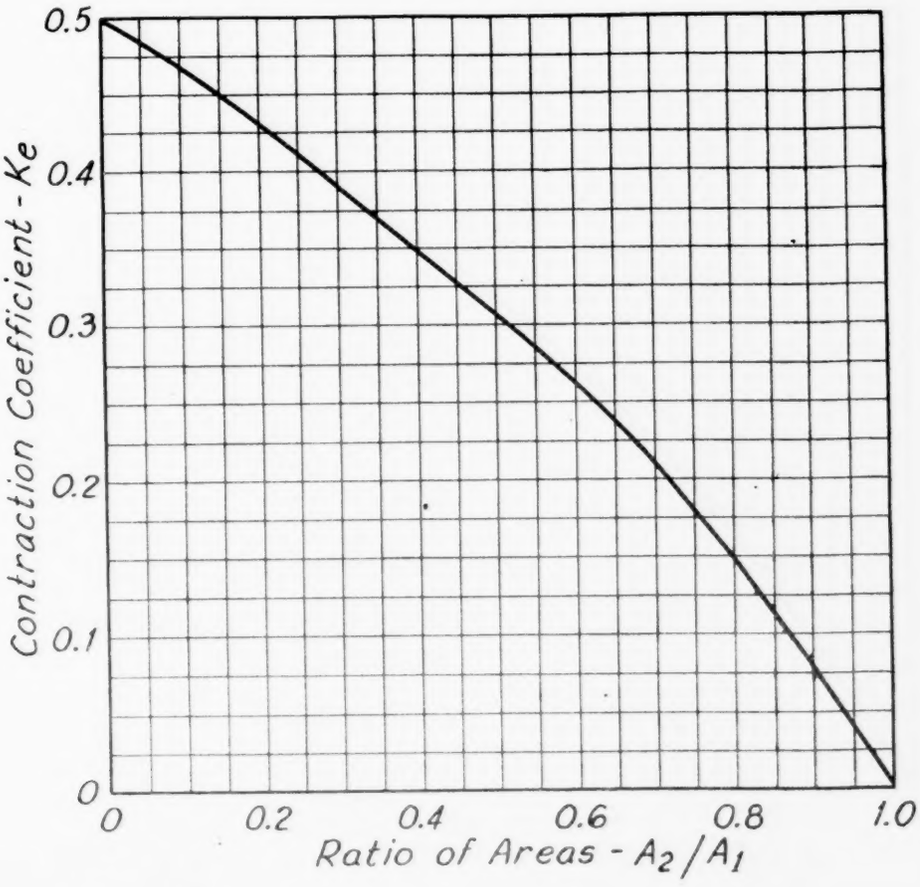


Fig. 16. Values of contraction coefficient, K_e, as shown in equation (53), for calculating pressure drop from small pipe to larger pipe.

types of obstructions, many of them indispensable, Bernouilli's theorem is an extremely powerful and useful tool.

Consider the enlargement CD in Fig. 14, and write the state of energy at C and D, thus

$$v_c/2g + P_c/p' = v_d^2/2g + P_d/p' + P_e/p'$$
$$(P_d - P_c) = v_c^2/2g - v_d^2/2g - P_e/p' \quad \ldots\ldots (49)$$

where P_e is the loss at the enlargement, and this shows that the decrease in velocity of the fluid in the larger section has been compensated by an increase in potential energy at D. If for the moment we neglect the loss P_e and remember that from the equation of continuity $A_c v_c = A_d v_d$, where A_c and A_d are the areas at the respective sections, then

$$(P_d - P_c)/p' = v_c^2/2g - (A_d^2/A_c^2)\, v_c^2/2g$$
$$= \left(1 - \frac{A_d^2}{A_c^2}\right)\frac{v_c^2}{2g} \quad \ldots\ldots \text{Eq (50a)}$$

where p' is the density of the fluid; or for a round pipe

$$\frac{P_d - P_c}{p'} = \left(1 - \frac{D_d^4}{D_c^4}\right)\frac{v_c^2}{2g} \quad \ldots\ldots \text{Eq (50b)}$$

or

$$v_c = \left[\frac{2gP}{p'\left(1 - \frac{D_d^4}{D_c^4}\right)}\right]^{\frac{1}{2}} \quad \ldots\ldots \text{Eq (50c)}$$

where $P = P_d - P_c$ and D_c and D_d are the diameters of the terminals of the enlargement.

ENLARGEMENTS AND CONTRACTIONS

Now, Equations (50a) and (50c) are approximations since we have neglected P_e. Returning to our initial Equation (50)

$$P_e/p' = (v_c^2 - v_d^2)/2g + (P_c - P_d)/p'$$

The work done between C and D (assuming that the cross-sectional area of the stream does not change) in moving w pounds (say) of fluid per second is $(v_c - v_d)\, w/g$. Since this is done at the expense of a loss of total potential energy, we have

$$A_d P_d - A_d P_c = (v_c - v_d)\, w/g$$
$$P_d - P_c = (v_c - v_d)\, w/g\, A_d$$

Substituting in Equation (49) and remembering that $w = A_d v_d\, p'$

$$P_e/p' = (v_c^2 - v_d^2)/2g - (v_c - v_d)\, v_d/g$$

or

$$P_e/p' = (v_c - v_d)^2/2g \quad \ldots\ldots (51a)$$

In terms of the areas of the sections

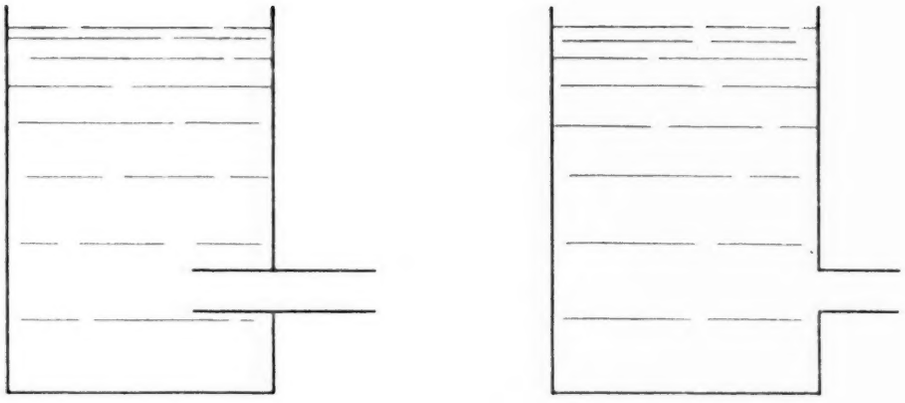
$$\frac{P_e}{p'} = \left(1 - \frac{A_c}{A_d}\right)^2 \frac{v_c^2}{2g} = \left(\frac{A_d}{A_c} - 1\right)^2 \frac{v_d^2}{2g} \quad (51b)$$

Equation (51) has been tested and found accurate within 2%. A more accurate formula for water flow through an enlargement is as follows. If p' is the density of water and P is expressed in pounds per sq ft, then

$$\frac{P_e}{p'} = 0.98\ (v_c - v_d)^{1.92}/2g \quad \ldots\ldots (52$$

Minimum losses are naturally attained when the diverging section has an included angle which is small, and of the order of 7° or less. Theoretically, Equation (51) should apply to contracting sections as well, but it has been shown by experiment that in such cases the losses are much less and can usually be neglected.

In the case of rectangular ducts carrying air, Equation (51) is approximately correct for both gradual and abrupt enlargements. Fig. 15 gives the streamlines in the larger section of a 6 × 6 in. to 11¾ × 11¾ in. enlargement, and is based on data published by the University of Illinois. The region of discontinuity shown by dotted lines is estimated. So far as is known no similar data exist for other sections or fluids. In passing



A. Re-entry Tube (Borda type)

B. Flanged Opening

Fig. 17. Showing two conditions of pipe entry into reservoir which may affect entrance losses.

it may also be noted that Equation (51b) may be written simply as

$$P_e/p' = K_e v_c^2/2g \quad \ldots\ldots (53)$$

where K_e is written for the term in parentheses. Values of K_e are shown in Fig. 16.

Example. Water flowing in a 3-inch diameter pipe suddenly passes through an enlargement to a 4-inch diameter pipe. Calculate the pressure drop if the velocity in the smaller pipe is 5 ft per sec.

1. Using Equation (53), we have from Fig. 16 when $A_c/A_d = 0.75$, $K = 0.18$, so that

$$P_e/p' = 0.18 \times \frac{4}{2 \times 32.2} = 0.112 \text{ ft of water, or}$$

$$\frac{0.112 \times 62.3}{144} = 0.0484 \text{ lb per sq in.}$$

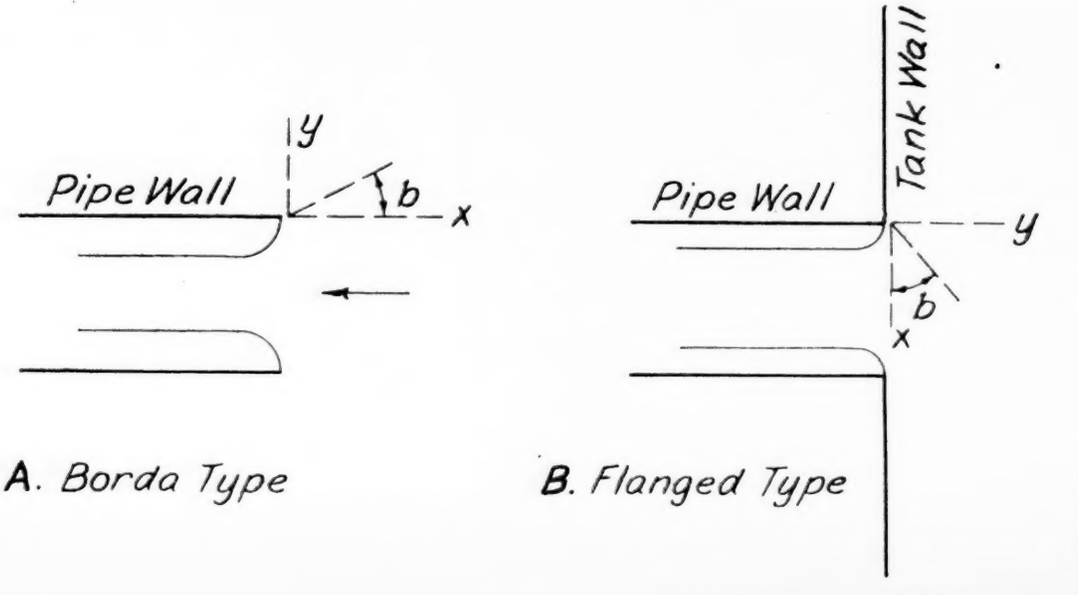
ENTRANCE LOSSES

It has been stated above that Equation (53) applies to sudden contractions, although the losses as calculated have proved experimentally to be rather high. If a fluid flows from a large reservoir into a pipe, it might be expected that Equation (53) would give a reasonably close estimate. From Fig. 16 it is noted that when the cross-sectional area of the reservoir is very large as compared to that of the pipe, the ratios of the areas approach zero and $K_e = 1$. Actually, there is some loss, since fluid entering around the edges of the pipe (assumed abrupt) creates a vortex and the flow is constricted. The nature of this effect and its extent will depend in part on the location of the pipe in the reservoir. Referring to Fig. 17 we have one condition where the opening is flush with the walls of the reservoir and another where the opening protrudes into it. The value of K_e in the first case is 0.5 and 1.0 in the second.

The shape of the opening also has a marked effect upon the amount of loss. If in the first diagram of Fig. 17 the opening is rounded or bell-shaped, a value of $K_e = 0.05$ is possible. But it is in the case of air flow where hoods are used that entrance losses play an important part in design. In these problems, air is drawn from an infinite space around the opening. Hoods are generally rectangular or conical in shape. As a rule the amount of flare is of little consequence. Some values of K_e for such hoods are given in Table 6.

TABLE 6.—VALUES OF K_e FOR RECTANGULAR AND CONICAL OPENINGS FOR AIR.

Type of Hood	Dimensions (Inches)	Value of K_e
Square	4 × 4	0.77
Square	8 × 8	0.79
Rectangular	6 × 8	0.49
Rectangular	7½ × 10	0.46
Rectangular	6 × 12	0.44
Rectangular	8 × 16	0.40
Rectangular	4 × 12	0.37
Conical	8 to 4	0.90



A. Borda Type

B. Flanged Type

Fig. 18. Showing streamline effect of two types of opening illustrated in Fig. 17.

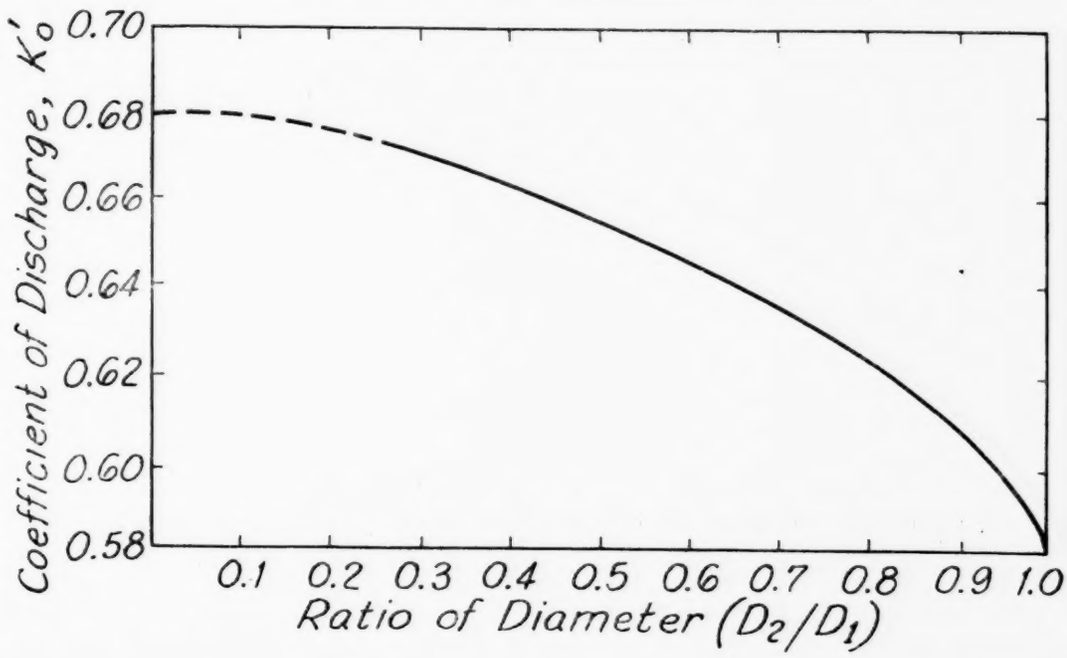


Fig. 19. Values of K_o' for various diameter ratios, equation (57).

It is possible to calculate mathematically the best shape of openings for the type of openings shown in Fig. 17. Using the coordinate systems designated in Fig. 18, we have for the reentrant opening of width 2π

$$x = \sin^2 1/2b - \log_e \sec 1/2b \quad \ldots\ldots (54)$$
$$y = 1/2\ (b - \sin b)$$

These are actually the equations of the free streamlines and at the point where they become parallel we reach the point of greatest contraction. If the free streamlines are to be calculated for a 6-inch diameter reentrant pipe the values of x and y must be multiplied by $6/\pi$. From these equations we have that $y = -\frac{1}{2}\pi$ when $b = \pi$ and $x = -\infty$. That is, when the streamlines become parallel the distance between them is π. Hence the coefficient of contraction is $\pi/2\pi = 0.5$.

In the second case for the pipe flush with the walls of the reservoir (see Figs. 17 and 18), the equations of the free streamlines which express the best shape of opening for this condition are

$$x = 1 - \cos b$$
$$y = \log_e (\tan b + \sec b) - \sin b \quad \ldots\ldots (55)$$

For a 6-inch diameter opening the values of x and y are multiplied by $6/\pi + 2$, the denominator indicating the mathematical width of the opening. Here again we may show that the point at which the free streamlines become parallel are at a distance $6\pi \div (\pi + 2)$ apart. Hence, the coefficient of contraction is

$$\pi \div (\pi + 2) = 0.613.$$

From the point of greatest contraction in each of the above cases we may, if desired, enlarge to any diameter. This enlargement should be gradual so that the static region is as complete as possible. However, we must remember that the enlargement results in some loss and it is better to fix the diameter of the pipe desired as that at the point of greatest constriction, and by trial and error determine the outline of the opening.

ORIFICE LOSSES

We may proceed to solve orifice losses in much the same way as in the examples already given. However, it is preferable to use Equation (50b), written as follows:

$$\frac{P}{p'} = K_o\left(\frac{D_1^4}{D_2^4} - 1\right)\frac{v_1^2}{2g} \quad \ldots\ldots (56)$$

where P/p' is the pressure loss in units of fluid column height, K_o a suitable constant which for a sharp-edged orifice is 0.78, D_1 the diameter of the pipe, and D_2 the diameter of the orifice. Since orifices are used for measurement of the fluid volume flowing, Equation (50a) is generally used in the form

$$V = K_o' \frac{\pi D_1^2 v_1}{4}\left[\frac{2gP}{p'\left(\frac{D_1^4}{D_2^4} - 1\right)}\right]^{\frac{1}{2}} \quad \ldots\ldots (57)$$

The value of K_o' is generally taken as 0.61 $(= 0.78^2)$. Because of their importance as measuring devices, sharp-edged orifices have been carefully investigated. Fig. 19 shows the values of K_o' for various ratios of diameters.

It is clear that orifices create considerable losses in a pipe system even when advantageously used as measuring devices of considerable accuracy. For this reason, "shaped" orifices are frequently used, one of the most common being the Moss orifice. When properly designed and used this orifice gives values of K' = 0.95.

ABRUPT CONTRACTION

We shall now develop a rational formula which gives the underlying theory of loss through valves. Unfortunately the formula as given here is not widely used since the constants are usually grouped into one. For reasons of simplicity this form is undoubtedly preferable. We have already shown that the formulas developed for abrupt enlargement apply to abrupt contractions. However, for the basic reasoning underlying valve-theory further discussion is given here.

Fig. 20a shows the nature of the flow through an abrupt contraction in a pipe.

Note the constriction at C where there is a sudden increase in velocity. From the equation of continuity

$$\text{Volume of flow, } V = A_a v_a = A_c v_c = A_b v_b$$

where the A's and v's denote the areas and fluid velocities respectively at the sections so marked. If the amount of constriction at C is determined in terms of the area A_b so that $A_c = K_c A_b$, then K_c is called the constriction coefficient. We also have $v_c = v_b/K_v$, where K_v is the coefficient of velocity. Now the loss due to the contraction may be regarded as being in two parts, the first due to contraction from point A to C (usually neglected), and the second to enlargement from C to B. Proceeding as in previous paragraphs we may show that the loss due to change in velocities is

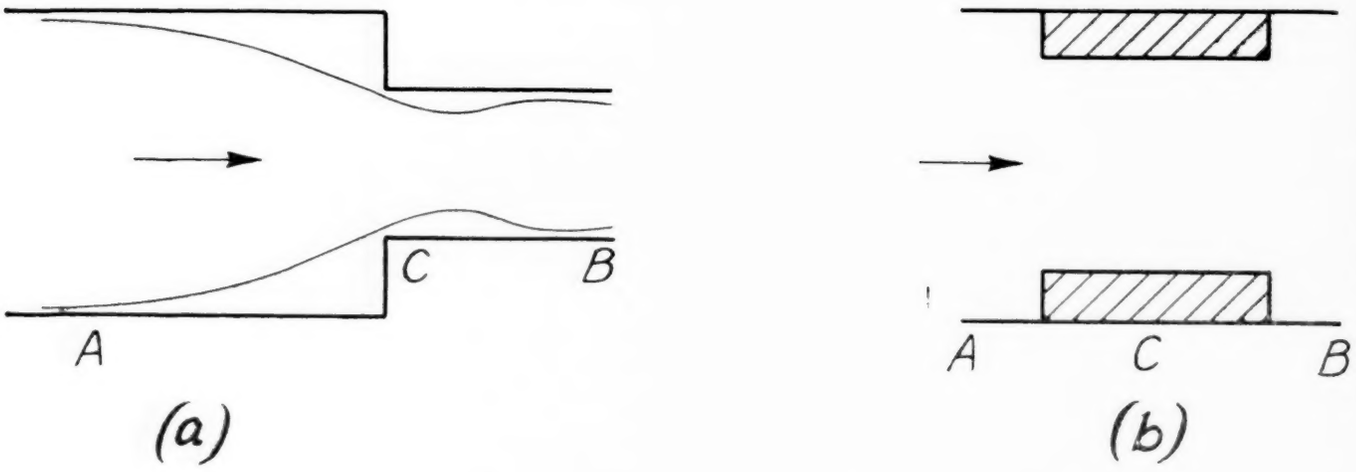


Fig. 20. Left (a), showing nature of flow at abrupt contraction, and right (b), diaphragm considered as valve partly open.

$$\frac{P_c}{p'} = \left(\frac{1}{K_v^2} - 1\right)\frac{v_c^2}{2g} \quad \ldots\ldots\ldots (58)$$

and that due to enlargement according to Equation (51a) is

$$P_e/p' = (v_c - v_b)^2/2g$$

Adding this and Equation (58) we obtain the total loss by contraction P_{co}

$$\frac{P_{co}}{p'} = \left(\frac{1}{K_v^2} - 1\right)\frac{v_c^2}{2g} + \frac{(v_c - v_b)^2}{2g}$$

and substituting for v_b in terms of v_e ($v_b = v_c/K_c$)

$$\frac{P_{co}}{p'} = \left[\frac{1}{K_c^2}\left(\frac{1}{K_v^2} - 1\right) + \left(\frac{1}{K_c} - 1\right)^2\right]\frac{v_c^2}{2g} \quad \ldots (59)$$

$$= K_{co}\, v_c^2/2g \quad \ldots\ldots\ldots\ldots\ldots (60)$$

The value of K_v generally used is 0.975. Values of K_{co} in terms of the areas of pipe are given in Table 7.

TABLE 7.—VALUES OF K_c, K_{co}, AND K_{d1} IN TERMS OF THE AREAS OF SECTIONS.

Ratio of Areas A_b/A_a	Value of K_c	Value of K_{co}*	Value of K_{d1}
0.1	0.632	0.469	233
0.2	0.644	0.431	49
0.3	0.659	0.387	18
0.4	0.676	0.343	8
0.5	0.696	0.298	4
0.6	0.717	0.257	2
0.7	0.744	0.212	1
0.8	0.784	0.161	0.4
0.9	0.890	0.079	0.2
1.0	1.000	0	0

Based on a value of $K_v = 0.975$.

Referring to Fig. 20b, which shows a diaphragm that may be considered as a valve partly open, we have $A_a = A_b$ and $v_a = v_b$ (when the flow in both sections is uniform). Hence writing $v_a = v_b = v$ and

$$\frac{P_{d1}}{p'} = \left[\frac{A^2}{A_c^2 K_c^2}\left(\frac{1}{K_v^2} - 1\right) + \left(\frac{A}{A_c K_c} - 1\right)^2\right]\frac{v^2}{2g} \quad \ldots (61)$$

$$= K_{d1}\, v^2/2g \quad \ldots\ldots\ldots\ldots\ldots (62)$$

where K_{d1} is written for the term in brackets. Note that since K_v is very nearly unity, Equations (59) and (62) reduce to relatively simple forms if the term

$$(1/K_v^2 - 1) = 0.$$

While in general the losses through various obstructions vary as the square of the velocity, there is reason to believe that in some cases they may vary as some exponent ranging from approximately 1.85-2.00. However, thus far there are only limited data to verify this possibility. Equation (52) appears to indicate this for the use of a gradual enlargement, and indeed with certain valves and other fittings this seems to be true. Most engineers prefer the rational form of equation simply because at best the prediction of losses in fittings is a matter of approximation.

VALVES

Equation (62) applies to most valves and the values of K_{d1} in Table 7 are of the correct order of magnitude. Unfortunately it cannot always be predetermined at what position a valve will be used in operation. As may be seen from Table 7, throttling reduces the ratio of the valve opening area to pipe area with the result that K_{d1} is increased greatly. The best value of K_{d1} to be used for design purposes is consequently one of serious importance. In Table 8 are presented some of the generally accepted values for the constant K_{d1}.

TABLE 8.—VALUES OF K_{d1} FOR VARIOUS VALVES.

Type of Valve	Value of K_{d1}
Gate valve (small)	
Fully open	0.19
1/4 closed	1.15
1/2 closed	5.6
3/4 closed	24.0
Gate valve (24-inch)	
1/3 closed	0.77
1/2 closed	3.27
3/4 closed	22.7
Globe valve	10.0
Angle valve	5.0
Swing check valve (fully open)	2.5

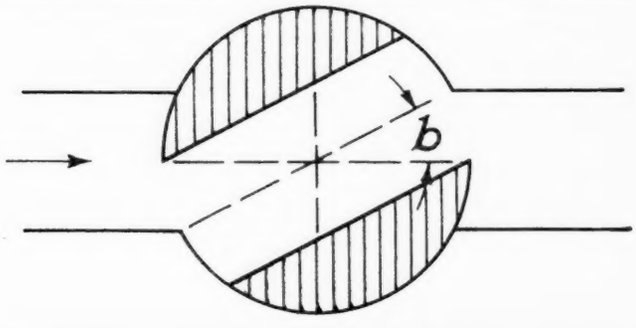


Fig. 21. Angle of turning (b) for Weisbach's equation (63) for cocks.

The early experiments by Weisbach on cock valves (see Fig. 21) show an interesting relationship between loss and angle of turning.

The empirical relationship which best fits his data is

$$\frac{P}{p'} = (0.14e^{0.12b})\frac{v^2}{2g} \quad \ldots\ldots\ldots\ldots\ldots\ldots (63)$$

where b is the angle as measured in Fig. 21 and ranges from 0 when it is fully open to 82 deg when closure starts. The relationship in terms of the ratio of areas is also the same except that the exponent is negative, of course. In the cock-type valve we have a change of direction of flow, an abrupt constriction, followed by enlargement and change of direction combined. In spite of these conditions, however, the order of the losses sustained is again in agreement with those for K_{61} in Table 7.

BENDS

The loss through a bend is usually small. However, since most piping systems contain a large number of these fittings, it is important that they receive adequate treatment. The subject of loss through different kinds of bends has received rather extensive treatment although still insufficient to cover all the types usually encountered in practice. We begin this discussion with a formula due to Weisbach, shown in Fig. 22a.

This formula is

$$\frac{P}{p'} = \left(0.95\sin^2 b + 2.05\sin^4\frac{b}{2}\right)\frac{v^2}{2g} \quad \ldots\ldots\ldots (64)$$

where P_b is the pressure drop through the bend, b the angle designated in Fig. 22, and v the velocity through the pipe connecting the bend. Weisbach's formula is based on experiments made with a bend about 1.2 inches in diameter, and it has never been satisfactorily determined whether it may be applied generally. McElroy recognized the limitations of this formula and preferred the following:

$$\frac{P}{p'} = \left(\frac{b^2}{8100}\right)K'\frac{v^2}{2g} \quad \ldots\ldots\ldots\ldots (65)$$

where b is measured in *degrees* and K' is the bend coefficient of a right angle elbow having the same diameter and general configuration. Results of further analysis of this type of bend by Kirchbach can be expressed by the following equation

$$\frac{P}{p'} = \left(0.04e^{0.04b}\right)\frac{v^2}{2g} \quad \ldots\ldots\ldots\ldots\ldots (66)$$

When the corners are not angular but curved as in Fig. 22b, Weisbach obtained the following formula:

$$\frac{P}{p'} = \frac{b}{180}\left[0.131 + 1.85\left(\frac{D}{2R}\right)^{7/2}\right]\frac{v^2}{2g} \quad \ldots\ldots (67)$$

where b is measured in degrees and R is as defined in the figure. The formula is only approximate and it is not known whether its application is general.

Still another formula by Weisbach applicable to right angle bends of the type shown in Fig. 22c is the following:

$$\frac{P}{p'} = \left(0.065 + 0.923\frac{D}{2R}\right)\frac{v^2}{2g} \quad \ldots\ldots\ldots (68)$$

It is believed that Equation (68) is the more accurate. The ratio D/2R or its inverse 2R/D is a sensitive index of the loss through elbows. Formulas have also been developed in which the length of the bend is accounted for. This is usually done by introducing the loss from an equivalent length of pipe. Thus Alexander, on the basis of Saph and Schoder's experiments on 2-inch brass pipe, obtained the relation

$$\frac{P_x}{p'} = 0.00086\left(\frac{D}{2R}\right)^{0.83} lv^{1.76} \quad \ldots\ldots\ldots (69)$$

where P_x is the pressure loss through the bend *in excess* of the friction loss for an equal length l of straight pipe. Table 9 shows the influence of radius of bend and pipe diameter on bend losses.

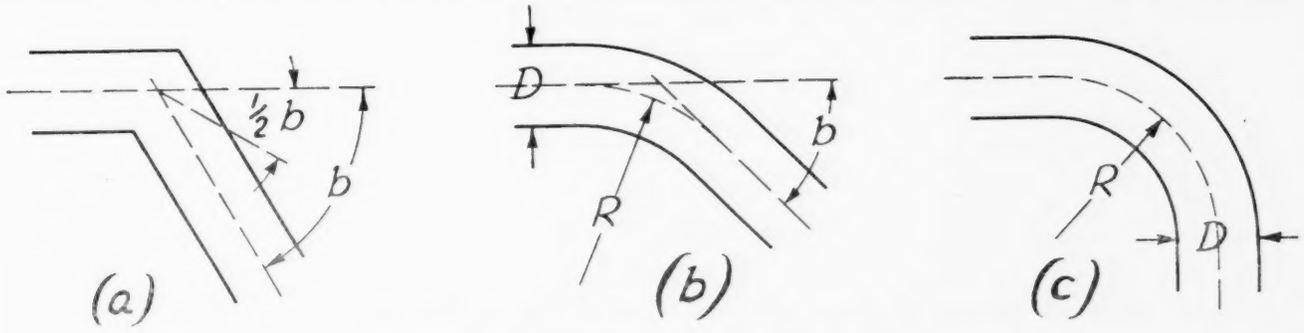


Fig. 22. Angular bend (a), curved bend (b), and curved 90° bend (c) which illustrate equations (64), (67), (68).

TABLE 9.—EXCESS LOSS OF PRESSURE IN RIGHT ANGLE BENDS 80 DIAMETERS IN LENGTH.

Dia. of Pipe, Inches	Value of 2R/D								
	4	5	6	8	10	20	30	40	50
	% Increase Over Loss in Equal Length of Pipe								
12	10.8	—	17.1	38.2	—	—	—	—	—
30	14	13	14	18	24	50	67	80	93

In several experiments a minimum excess loss was observed when the ratio 2R/d was equal to 5. Further experiments by Davis and Brightmore in modern elbow fittings of small diameters are given in Table 10.

TABLE 10.—EXCESS LOSS IN PRESSURE DUE TO 90 DEG. FITTINGS.

Diameter of Fitting, Inches	Fluid Velocity (Ft per Sec)	Value of 2R/D						
		1.45	4.00	5.00	10.0	12	16	20
		% Increase Over Loss in Equal Length of Pipe						
2 1/16	2	0.040	—	0.0086	0.0043	—	—	—
	4	0.17	—	0.048	0.032	—	—	—
	6	0.37	—	0.14	0.11	—	—	—
	8	0.66	—	0.28	0.24	—	—	—
	10	1.0	—	0.50	0.47	—	—	—
3*	5	—	0.17	—	0.13	0.14	0.13	0.075
	10	—	0.64	—	0.59	0.63	0.55	0.28
4	5	—	0.16	—	0.12	0.13	0.11	0.083
	10	—	0.60	—	0.48	0.51	0.46	0.36

*Elbow artificially roughened.

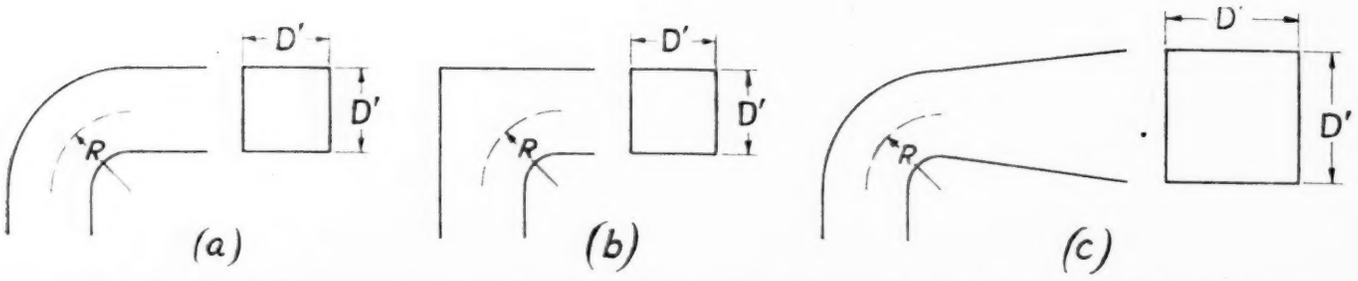


Fig. 23. Curved rectangular 90° bend (a); inner edge curved, outer square (b); and venturi bend (c).

We note in passing that there is a theoretically most efficient bend for any pipe of given diameter since an attempt to reduce the effect of bend alone increases the length of pipe, and hence adds to the resistance. This theoretical maximum is easily calculated by the methods of trial and error, although for practical purposes it is rarely required.

The results in Table 10 are for standard screwed fittings. For welded elbows Giesecke and Hopper obtained values ranging from 31 to 42% of those given. A compilation of available data on right angle elbows by six investigators gives the results shown in Table 11.

TABLE 11.—AVERAGE VALUES OF K_b AS DETERMINED BY SIX INVESTIGATORS.

For the general equation

$$\frac{P}{P'} = K' \frac{v^2}{2g}$$

2R/D	1	2	4	6	8	10	15	20
K_b	0.07	0.13	0.20	0.24	0.28	0.31	0.35	0.39

These coefficients are based on Reynolds' numbers of approximately 100,000. However, for turbulent suction, as shown by McAdams and his colleagues, the values of K' are sensibly constant throughout that region. In the streamline region values of K' range from 0.1 — 1 times that for the turbulent region, a reasonable practical value being 0.3.

Special Bends. These bends are usually found in ventilation practice and consist of rectangular sections, as shown in Fig. 23.

For the types of opening shown there are few experimental data. McElroy carefully summarized the available information on this subject and the reader is referred to his excellent paper (Bureau of Mines Information Circular 6663, 1932). Referring to Fig. 23a, the loss is given by the expression

$$\frac{P_b}{p'} = 0.25 \left(\frac{D'}{R}\right)^{\frac{1}{2}} \frac{v^2}{2g} \quad \ldots\ldots\ldots\ldots (70)$$

When the inner corner is curved and the outer is square, as in Fig. 23b, McElroy gives the equation as follows:

$$\frac{P}{p'} = 0.60 \left(\frac{D'}{R}\right) \frac{v^2}{2g} \quad \ldots\ldots\ldots\ldots (71)$$

McElroy found that the Venturi bend (Fig. 23c) was slightly less (0.8-0.9) than the value obtained from Equation (70). In general there is no reason to exceed ratios of R/D' greater than 2.0 and values of 1.5 give very good results.

When the section is rectangular, as in Fig. 24, the losses may be taken as follows:

$$\frac{P}{p'} = \frac{0.25}{\sqrt{W/D}} \left(\frac{D'}{R}\right)^{\frac{1}{2}} \frac{v^2}{2g} \quad \ldots\ldots\ldots\ldots (72)$$

TEES

Here again data on the loss through tees are limited. Giesecke and Badgett recommend values of K (the coefficient in the equation for loss through a tee, $\frac{P}{p'} = k \frac{v^2}{2g}$ equal to 1.8. This was obtained for a small fitting all of whose openings were the same. However, it is clear that the loss through a tee will depend upon the amount of water diverted. Table 12 gives some of Giesecke and Badgett's results, when water enters from the left of the tee and a part is directed at the bottom. The losses are expressed in terms of equivalent elbows at the latter point.

TABLE 12.—EQUIVALENT ELBOWS FOR LOSS IN TEE

(1 inch Tee with water flowing)

Per Cent Water Through Bottom of Tee	Number of Standard Elbows	
	For Water Through Bottom of Tee	For Water Straight Through Tee
20	28	—
40	6.5	1.4
60	3.2	0.3
80	2.3	0.11
100	1.8	0.06

Equivalent length. It is frequently preferable to express the loss through a fitting in terms of the length of pipe to which it is equivalent. This is easily done by combining Equation (17) and the general equation expressing the loss through fittings. $P/p' = Kv^2/2g$. Hence

$$f \frac{l}{D} \cdot \frac{v^2}{2g} = K \frac{v^2}{2g}$$

$$l_e = \frac{D}{f} K = \frac{D}{f} \quad \ldots\ldots\ldots\ldots (73)$$

TABLE 13.—EQUIVALENT LENGTH OF STRAIGHT PIPE FOR VARIOUS FITTINGS

Type of Fitting	Diameter of Pipe, Inches						
	1	2	4	6	8	10	12
	Equivalent Length, Feet						
Gate Valve, Fully Open	—	—	2.2	3.5	4.4	5.7	6.0
Gate Valve, Half Open	—	—	67	101	140	160	200
Globe Valve, Open	27	53	110	160	220	—	—
Angle Valve, Open	15	28	54	83	110	—	—
Swing Check Valve, Open	—	14	26	38	52	67	—
Return Bend (180°)	—	15	22	—	—	—	—
Elbow (90°), Standard	2.7	5.2	11	16	20	25	—
Elbow (45°)	1.3	2.5	5.0	7.8	10	15	—
Tee	5.3	12	21	33	44	52	—
Disc Meter	135 to 400						
Rotary Meter	400						

The term l_e is the equivalent *length resistance* of fittings and is a number denoting equivalence in pipe diameters or units of length, whichever is preferable. The term is useful in pipe computations and for this reason some of the usually accepted values for various kinds of fittings are reproduced in Table 13.

HEAT LOSSES

It is frequently important to provide a fixed temperature at a given point in a pipe system. To compute the temperature at the source we must determine the temperature drop due to losses. These losses are difficult to solve and require rather extended discussion to cover the many variables involved. In these paragraphs we attempt merely to set forth the most elementary principles involved and designate the procedures to be used.

We shall begin with a formula for determining the heat loss per foot of pipe when the surface temperature of the pipe is t and the surrounding temperature 70F:

$$K = BD^{0.65}\, e^{0.0025(t-70)} \qquad \text{.....(74)}$$

where K is the heat loss per ft of steel pipe per F difference in temperature, D the diameter of the pipe in inches, B a constant which has the following values:

For bare steel pipe	0.60
For bright copper pipe.....	0.25
For tarnished copper pipe.....	0.42
For 1 in. layer of 85% magnesia.....	0.09
For 2 in. layer of 85% magnesia.....	0.05

In Equation (74) D refers to the nominal pipe diameter and e is the base of the natural system of logarithms. Fig. 25 is a nomogram for computing K_s. Values for copper pipe and magnesia-lagged pipe are obtainable by multiplying the values for steel pipe by the necessary ratios or derived from the values of B above.

Since the heat loss is at the expense of the liquid, we may, with certain assumptions, obtain a suitable formula for determining the initial or final temperature in a given short length of pipe. Let the volume of fluid flowing per second be V, C_p the specific heat, p' the density of the fluid, t_o the initial temperature of the fluid, t_1 the final temperature of the fluid; then if the surface temperature of the pipe is the same as that of the fluid, we may write

$$Vp'\,C_p\,(t_o - t_1) = BLD^{0.65}\, e^{0.00125\left(\frac{t_o + t_1}{2} - 70\right)} \qquad \text{.....(75)}$$

(where L is the length of pipe in feet),
or if

$$BLD^{0.65}/Vp'C_p = C_1$$

$$t_o - t_1 = C_1 e^{0.00125\,(t_o + t_1 - 140)}$$

This equation may be solved for t_o or t_1, provided one or the other is given.

Example. Given 1000 ft of 4-inch diameter steel pipe lagged with 2 inches of 85% magnesia insulation. It is desired to deliver water at 100F at the rate of 2 cu ft per sec. Calculate the initial temperature t_o in order that this temperature may be maintained.

1. Reduce Equation (75) as follows:

$$\log (t_o - t_1) = \log C_1 + 0.00125\,(t_o + t_1 - 140) \log e$$
$$= \log C_1 - 0.076 + 0.00054\,(t_o + t_1) \qquad \text{.....(A)}$$

2. Calculate the value of C_1

$$C_{1000} = \frac{0.05 \times 1000 \times 4^{0.65}}{2 \times 62.3 \times 1} = 1.30$$

$$\log 1.30 = 0.114$$

so that

$$\log (t_o - 100) = 0.038 + 0.00054\,(t_o + 100)$$

3. (a) Try a value of $t_o = 102$ in Equation (A); then
$0.302 = 0.038 + 0.109$ (too high)
(b) Try a value of $t_o = 101.5$
$0.176 = 0.038 + 0.109$ (too high)
(c) Try a value of $t_o = 101.4$
$0.146 = 0.038 + 0.108$ (correct)

Hence $t_o = 101.4$F

Example. Obtain the initial temperature if bare steel pipe were substituted in the previous example.

1. We may show that for this case, $C_1 = 15.3$
2. Substituting in Equation (A) and simplifying $\log (t_o - 100) = 1.360 + 0.00065\,(t_o + 100)$
3. (a) Try a value of $t_o = 160$ (too high)
(b) Try a value of $t_o = 130$ (slightly high)
(c) It will be found that when $t_o - t_1 = 29$, the solution is obtained. Hence $t_o = 129$F.

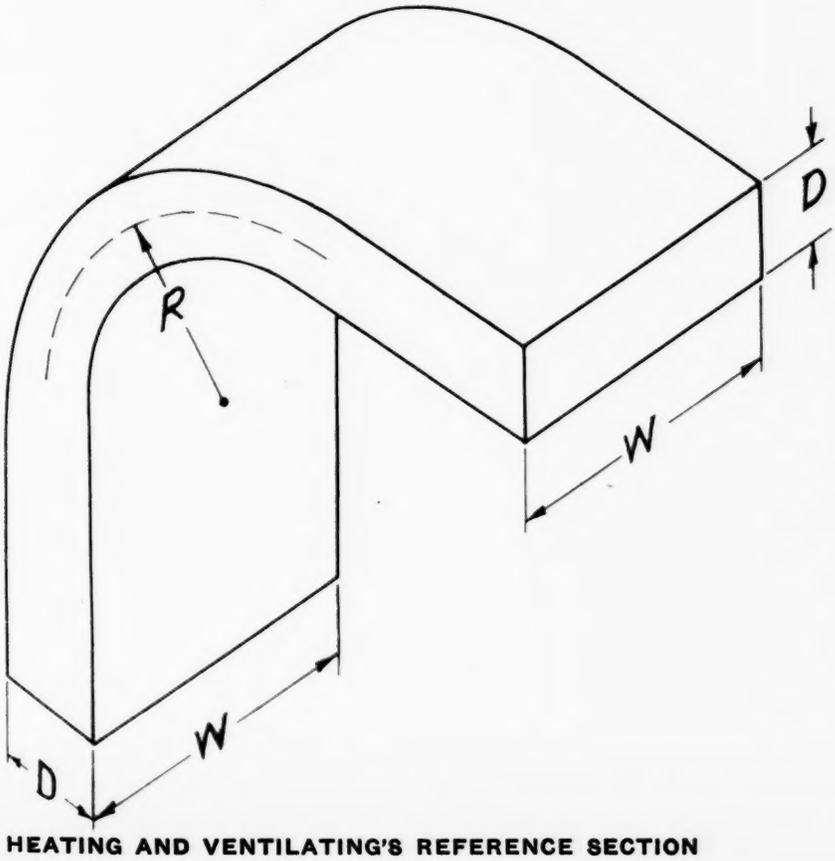


Fig. 24. Curved rectangular bend, loss for which is given in equation (72).

DEMAND AND DESIGN

The design and efficiency of a piping system depend upon the provision of adequate flow and pressures at necessary points. If the requirements are once known, a suitable system can be designed. However, the problem is not so simple, except in a few instances such as a long oil-pipe line when the delivery at a given point is either constant or nearly so for long intervals of time. Industrial piping systems are usually designed for intermittent use at different points, often quite close together, but not all in operation at the same time. The problem posed is this: How often may we expect 1, 2, 3,... r of n fixtures to be in operation at any one time and what are their separate requirements? Obviously, if we can determine this we can reduce the pipe sizes and hence the first cost and operation of the system.

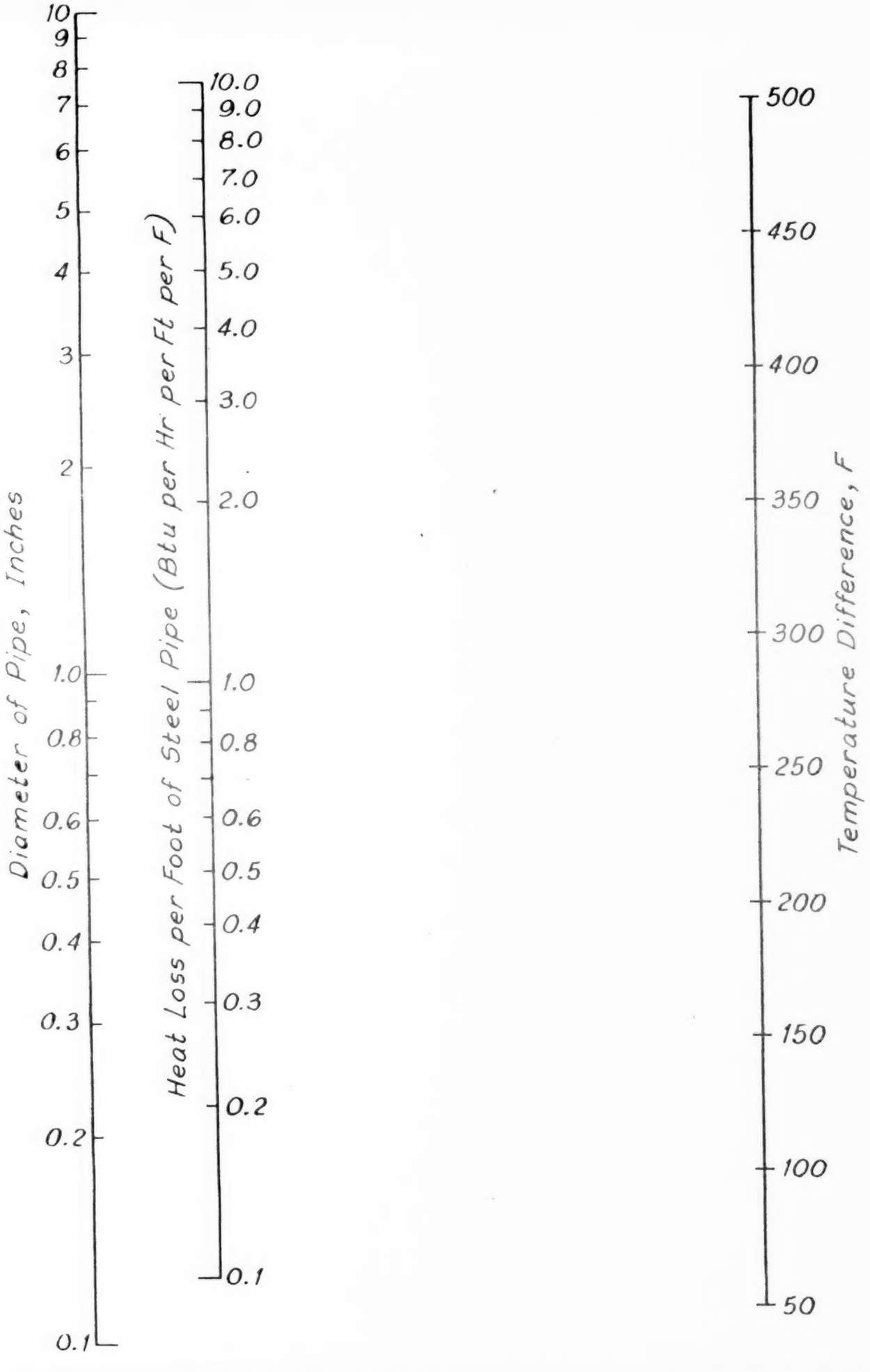


Fig. 25. Nomogram for computing K, equation (74). For bright copper pipe multiply the value of K found on the chart by 0.416; for tarnished copper by 0.70; for 1 in. of 85% magnesia on steel pipe by 0.15, and for 2 in. of magnesia by 0.083.

This problem may be solved by trial and error as is usually the case, or by a method due to Hunter (National Bureau of Standards, Report BMS79, 1941). Hunter generalized the problem mentioned by stating that each fixture operated for t seconds duration once every T seconds, the times being averages. The problem may be solved by the methods of combination and permutation. Thus, one of the n fixtures (all things being equal) will have a probability of being operated at a particular instant given by the ratio t/T. The probability that it will not be in operation will be $1 - t/T$ or $(T - t)/T$. From the law of combinations the probability that none of the remaining $(n - 1)$ fixtures will be in operation at a given time will be $[(T - t)/T]^{n-1}$. Again the probability that one of the n fixtures will be in operation at the given time is

$$p_1^n = n\left(\frac{t}{T}\right)\left(\frac{T-t}{T}\right)^{n-1} \quad \ldots\ldots\ldots (76)$$

More generally, r fixtures will be in operation at a given instant in accordance with the expression

$$p_r^n = \left(\frac{n!}{r!\,(n-r)!}\right)\left(\frac{t}{T}\right)^r\left(\frac{T-t}{T}\right)^{n-r} = C_r^n \frac{t^r\,(T-t)^{n-r}}{T^n} \quad \ldots\ldots\ldots\ldots\ldots (77)$$

where C_r^n is written for the expression in the first parenthesis, which is the number of combinations of r fixtures out of n. The complete Equation (77) signifies the probability that r out of n fixtures are in operation at a given time. If we multiply this equation by S (time in seconds)

$$SP_n^r = SC_r^n\left(\frac{t}{T}\right)^r\left(\frac{T-t}{T}\right)^{n-r}$$

and put it equal to unity, so that

$$\frac{1}{S} = C_r^n\left(\frac{t}{T}\right)^r\left(\frac{T-t}{T}\right)^{n-r} \quad \ldots\ldots\ldots (78)$$

we have an equation which means that r fixtures will be in simultaneous operation for 1 second out of every S seconds that all n fixtures are in use at an assumed rate. We also have that a chosen design factor $r = m$ will not be exceeded by more than a given fraction of the time 1/S, given by the expression

$$\sum_{r=m+1}^{r=m} P_r^n = \frac{1}{S} \quad \ldots\ldots\ldots\ldots\ldots (79)$$

The series represented by Equation (79) is tedious to compute, but it will be found that when p_m^r is equal to or less than 1/S, the design factor $r = m$ will not be exceeded less than 1/S of the time when $\frac{n-r}{r+1} \times \frac{t}{T-t} > \frac{1}{2}$. Summation will be necessary in order to determine the value of $r = m$ which will not be exceeded more than 1/S of the time.

From the expressions developed we see that we must have available average values of t, T, S, and the design load mV where V is the *average* flow per fixture during operation. Values of t and T can be determined only by observation in the case of similar installations, or else assigned values in accordance with their expected performance in a given instance. The term S is necessary in connection with Equation (79) in order to determine the probability that a particular value n of r does not exceed S a given percentage of the time.

Fig. 26, obtained by Hunter for flush valves and bath tubs, gives the relation between n and m for values of $1/S = 0.01$ (that is, the design factor will not exceed r more than 1% of the time). In the case of flush valves $t/T = 9/300 = 3/100$, and for bath tubs $t/T = 1/15$. Fig. 27 shows mV plotted against n for values of 27 gal per min and 8 gal per min respectively.

The above discussion is applicable generally to a system provided with many fixtures. It serves to illustrate the variables involved and the procedure to be used in analyzing the demand of a system. One other fact, however, deserves mention. When the demand varies greatly during the day, say with a peak in the morning and evening, we must resort to a careful anlaysis of our requirements. Similarly, if different fixtures require widely different loads it is necessary to weigh or average these loads in a way that takes nothing from them but aids in making the data so obtained applicable to the equations developed.

Design of system. Having estimated the load on a system, we next must compute pipe sizes, as well as losses and pressures required. Before continuing with an actual example it seems best to set down a few important rules of procedure. These rules are not intended to be applied universally since practical problems often require a treatment other than that shown in the example given. These rules are as follows:

(A) Determine the physical properties of the fluid which is to flow in the system. These include its density and viscosity for specified temperatures. If the fluid temperature changes rapidly from the point of supply to the point of delivery, we should inquire whether the fluid tends to congeal, condense, or in part become a gas or vapor. If these simple considerations are neglected we may often find that our piping system will not function properly. Under conditions where there is likely to be a temperature change which affects the fluid, the pipes should be lagged and their size and friction losses so estimated that due account is made for such occurrences.

(B) Sketch to scale in plan and elevation or perspective the lines of fluid flow from the source to points of delivery. Indicate the quantities and temperature of the fluid desired at each of these points. Also indicate the kind and type of fittings to be used at their proper locations.

(C) Whether the system operates under gravity or by any applied pressure, compute the pipe areas, beginning with the branches most remote from the source. Remember that wherever there is a tee or branch connection, the size of the pipe immediately upstream is equal to the sum of all the branch areas downstream.

(D) Since at every point of discharge the volume of flow is known beforehand, select a suitable pipe velocity. Obviously a lower velocity of flow means less friction, but at the same time the first cost of the pipe is higher. In most instances steam and gases are moved at much higher velocities than liquids, the range being roughly from 600 to 10,000 ft per min. Liquids are moved at relatively low velocity, ranging from 10 to about 2000 ft per min, depending upon the circumstances whether the fluid is gaseous or liquid. Most installations are designed for turbulent flow with Reynolds' numbers ranging from 10,000 to 100,000. Remember also that if not all outlets are operating at the same time, the size of the main may be made smaller. The procedure to be followed in this case has been outlined in earlier paragraphs of this section. Whenever possible velocities should be maintained as nearly constant as possible throughout the system.

(E) Having determined the velocities in the system, the areas of the branches are obtained from the equation of continuity $V_1 = A_1 v_1$; $V_2 = A_2 v_2$, etc., where the V's are the volumes of fluid required in branches 1, 2, 3, etc., and the A's and v's the respective areas and velocities. Select a pipe for each branch whose inside diameter is equivalent to that of the area computed. Do not overlook the fact that the nominal diameter of a pipe as obtained from catalogs is not the true inside diameter.

(F) Compute the losses in the various branches and in the main by means of previously given formulas and charts. The longer pipes at a T or Y will have higher

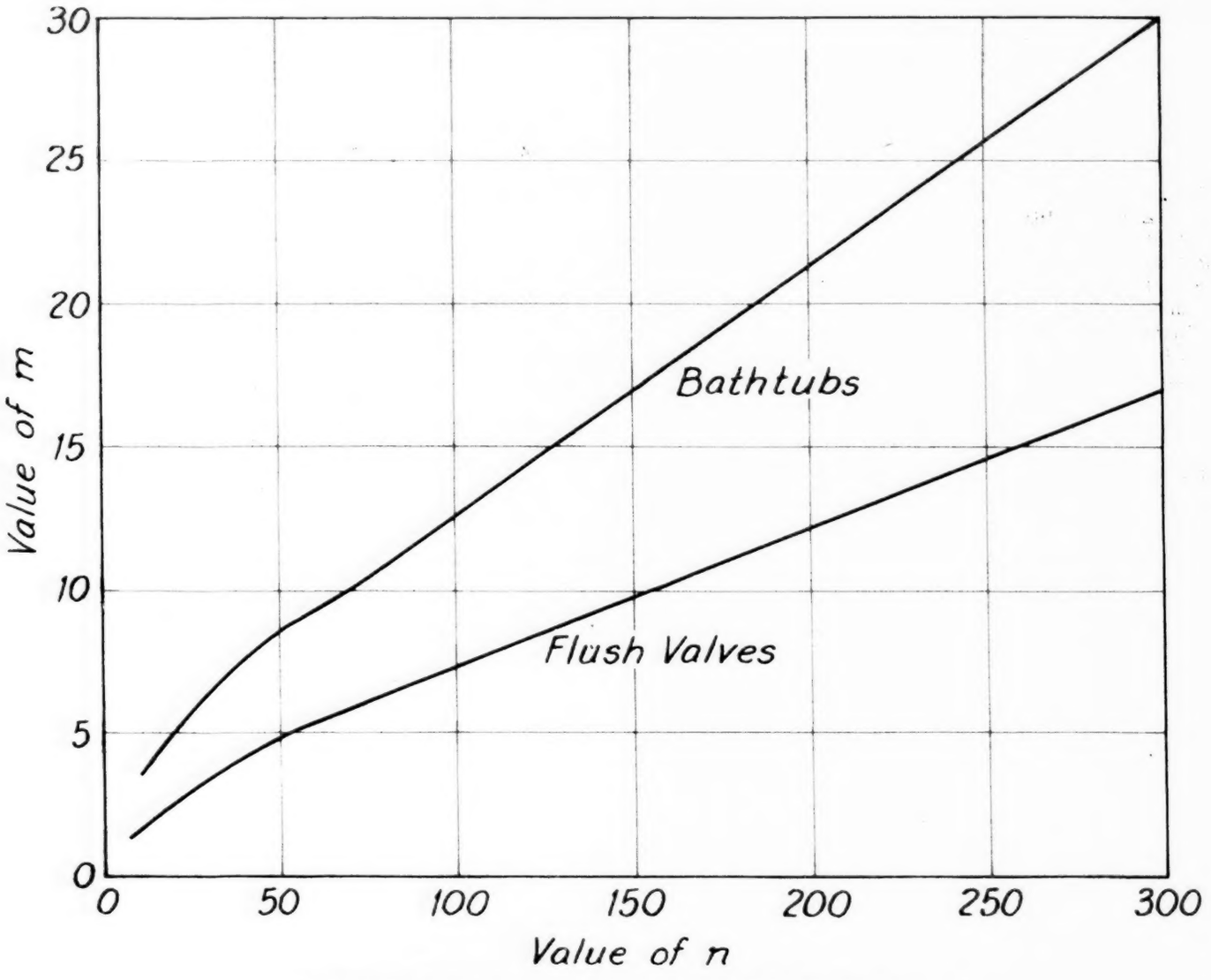


Fig. 26. Relation between m and n as reported by Hunter.

resistances than the shorter ones. This may often reduce the pressure at the point of discharge so that a larger pipe size is necessary to produce the required volume of flow. This is especially true in moving gases at low pressures. Add the fixture resistances to the pipe resistance.

(G) The point in the system most distant from the source is of greatest consequence since the flow at this point is determined by the resistance encountered throughout the whole length of pipe. This holds whether the source is under motion or pressure. It implies that the flow is the absolute sum of the resistances encountered by the flow and in turn establishes it. When we have established the flow at the most distant point from the source no difficulty will be encountered.

The procedure used in estimating pipe sizes and pressures required is illustrated by the following example.

Example. Given a pipe system to be laid out as shown in Fig. 28. Compute the losses and hence the pipe sizes required if the fluid is toluene at 68F. Assume that the interior of the pipe is smooth.

1. From Table 1, n = 0.000396 FPS units. Take the density at 0.866.
2. Select a suitable range of flow velocities, say from 20-30 ft per sec (since the available head = 36 ft and $v = \sqrt{2 \times 32.2 \times 36} = 48.1$ ft per sec and we have yet to consider losses).
3. Since the fluid is to descend by gravity from the tank, we must determine the pipe sizes so that the flow will be realized at points I and A for the pressure head available.
4. The theoretical pressure potential is 36 ft of toluene at A, and 21 ft at I. We may use up all of this pressure to get the required flow at A or only a part of it. From various pipe size relations which we are at liberty to make we may determine the total resistance in the system. Provided that for a given selection this resistance is less than the head, the flow will be maintained by regulating the valve. If the pressure drop is greater, then the pipe sizes must be increased.

Select a velocity of 20 ft per sec, and assume that the valve No. 2 is closed—that is, we are to deliver only 20 gal per sec. This delivery is equivalent to

$$20 \text{ gal per sec} \times 0.134 \text{ cu ft } (= 1 \text{ gal}) = 2.68 \text{ cu ft per sec}$$

$$\frac{2.68 \text{ cu ft per sec}}{20 \text{ ft per sec}} = 0.135 \text{ sq ft}$$

$$0.135 \text{ sq ft} = \frac{\pi D^2}{4 \times 144}$$

$$D = 5 \text{ inches I.D.}$$

5. Consider the length of pipe AF. The total resistance to flow includes the resistance of (a) 421 ft of 5-inch pipe, (b) 5 elbows (welded), and (c) one gate valve (No. 1).

   i. Calculate Reynolds' number to determine the nature of the flow and hence f.

$$R_e = \frac{p'vd}{n} = \frac{0.866 \times 62.3 \times 20 \times 5}{0.000396 \times 12} = 1{,}140{,}000$$

Hence the flow is turbulent, being > 2500. Now use Equation (21) for estimating the friction factor f

$$f = 0.0018 + \frac{0.1526}{(1{,}140{,}000)^{0.35}} = 0.0028$$

ii. From Equation (17)

$$\frac{P}{p'} = 0.0028 \times \frac{12}{5} \times 421 \times \frac{400}{2 \times 32.2} = 17.6 \text{ ft of toluene}$$

iii. Assume that the radius of the elbow is twice that of the pipe diameter, so that $2R/D = 20/5 = 4$. From Table 11, the value of $K = 0.20$. Since the elbows are welded the factor is roughly 40% of this, so that $K = 0.08$. Hence, using the standard equation

$$\frac{P}{p'} = K \frac{v^2}{2g} = 0.08 \times \frac{400}{2 \times 32.2} = 0.6 \text{ ft of toluene}$$

For five elbows the loss is

$$5 \times 0.6 = 3.0 \text{ ft of toluene}$$

iv. The loss through a 5-inch gate valve, fully open, from Table 8 and Equation (62) is

$$\frac{P}{p'} = 0.19 \times \frac{400}{2 \times 32.2} = 1.2 \text{ ft of toluene}$$

6. The total loss thus far is: items (ii) + (iii) + (iv), or 17.6 + 3.0 + 1.2 = 21.8 ft of toluene for a total of 36 ft of available head. This represents the loss from A to G and hence the available pressure at G for the branch FG is 36 — 21.8 = 14.2 ft.

At F we have an enlargement, unless the loss from G to K is such that it does not exceed the value of 14.2 for a velocity greater than 20 ft per sec. A simple calculation shows that the margin of available head will be quite small, and therefore it is best to use a pipe diameter of larger size. This diameter will be:

(20 + 10) gal per sec × 0.134 cu ft per gal = 4.02 cu ft per sec

$$\frac{4.02 \text{ cu ft per sec}}{20 \text{ ft per sec}} = 0.2 \text{ sq ft}$$

Hence the equivalent diameter for this area is 6 inches I. D.

7. Consider now the length of pipe GK. The total resistance to flow includes: (a) the resistance of 115 ft of 6-inch pipe, (b) an enlargement at G, (c) an elbow at J, (d) a tee slightly upstream of G, (e) a gate valve (No. 3) near K, and (f) the entrance loss at K.

i. $$R_e = \frac{0.866 \times 62.3 \times 20 \times 6}{0.000396 \times 16} = 1{,}137{,}000$$

$$f = 0.0018 + \frac{0.1526}{(1{,}137{,}000)^{0.35}} = 0.0028$$

ii. From Equation (17)

$$\frac{P}{p'} = 0.0028 \times \frac{12}{5} \times 165 \times \frac{400}{2 \times 32.2} = 5.8 \text{ ft of toluene}$$

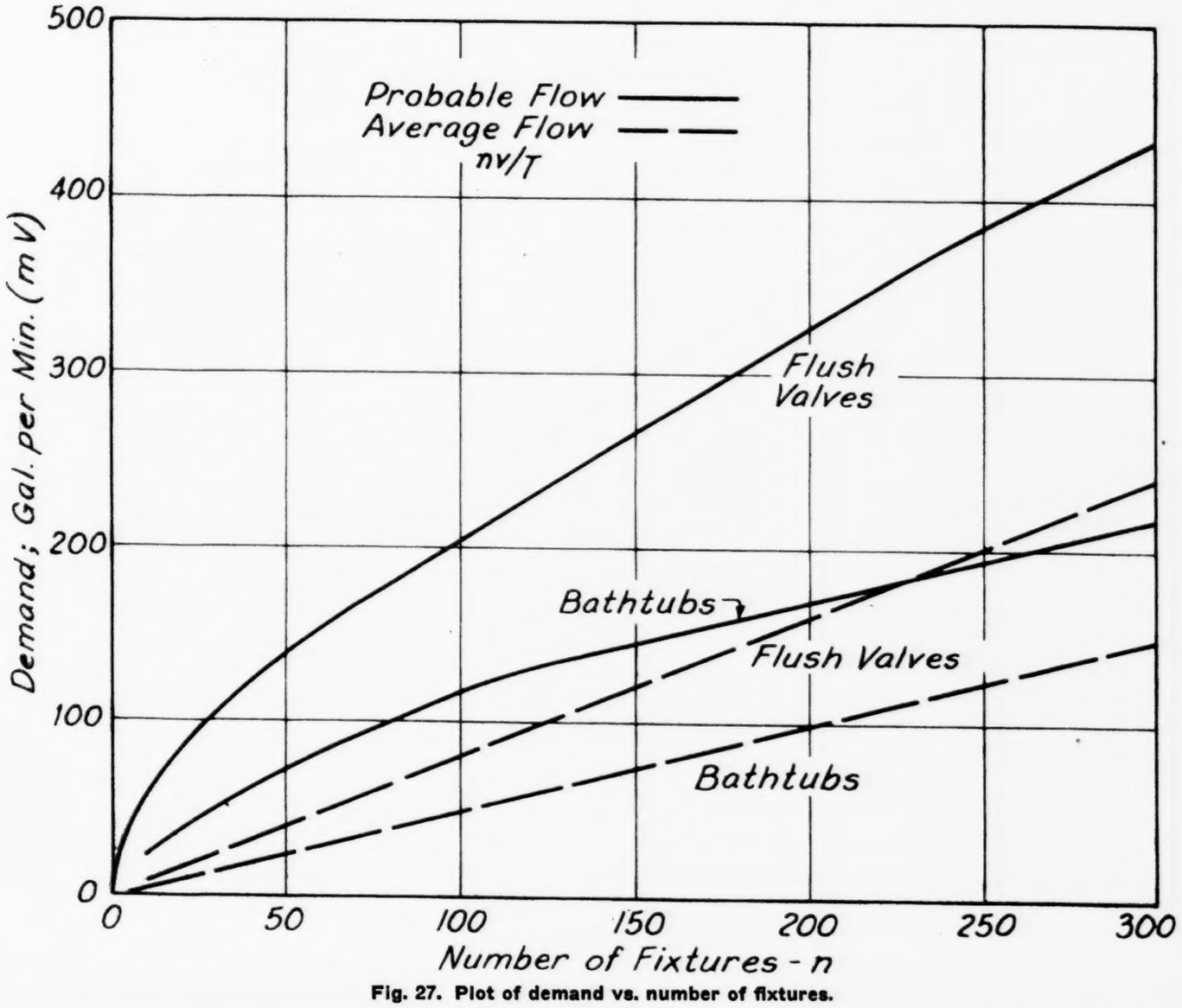


Fig. 27. Plot of demand vs. number of fixtures.

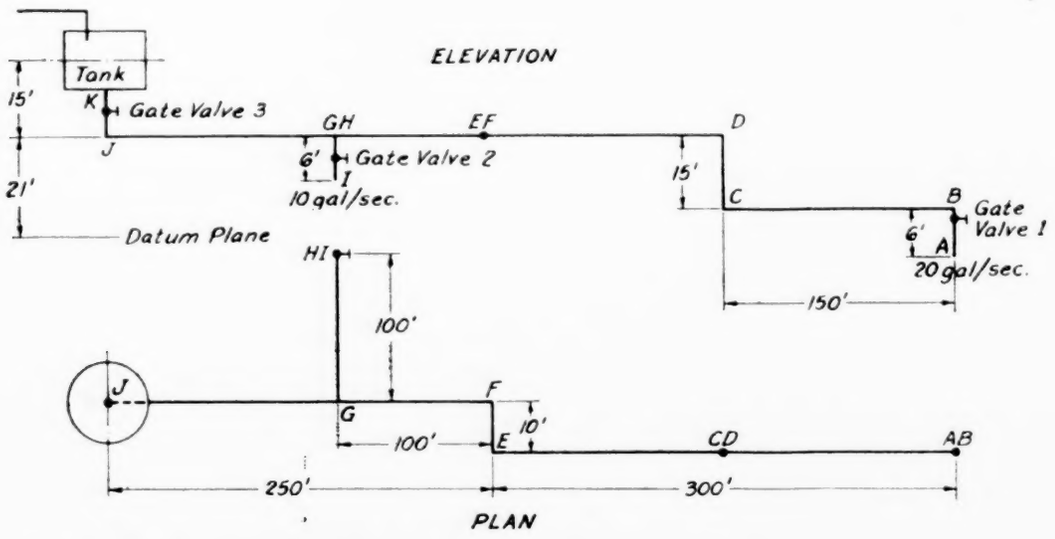


Fig. 28. Layout of toluene piping for accompanying example.

iii. **The velocity of the fluid beyond the tee and prior to the contraction to the 5-inch pipe is evidently 2.68/0.2 = 13.4 ft per sec. Hence the loss due to enlargement is, by Equation (51)**

$$\frac{P}{p'} = \frac{(20-13.4)^2}{2 \times 32.2} = 0.68 \text{ ft of toluene}$$

iv. **The elbow loss will be the same as in 5iii above:**

$$\frac{P}{p'} = 0.6 \text{ ft of toluene}$$

v. **The loss through the tee may be obtained by use of iv and Table 12. Since 67% of the water passes straight through we may take the loss as equal to that of one elbow, or**

$$\frac{P}{p'} = 0.6 \text{ ft of toluene.}$$

vi. **The loss through the gate valve is the same as 5iv, that is**

$$\frac{P}{p'} = 1.2 \text{ ft of toluene.}$$

vii. **The entrance loss, assumed abrupt, may be taken as ½ the velocity head, that is**

$$\frac{P}{p'} = 0.5 \times \frac{400}{2 \times 32.2} = 3.1 \text{ ft of toluene}$$

The total loss from G to K is therefore the sum of items (ii) to (vii).

Total loss GK = 5.8 + 0.7 + 0.6 + 0.6 + 1.2 + 3.1 = 12.0 ft of toluene.

Total loss AK = 21.8 + 12.0 = 33.8 ft of toluene. Hence we see that 32 ft out of 36 ft of head of toluene is used up in resistance to overcome the loss from A to K, and we conclude that in so far as the required delivery at A is concerned the pipe sizes are adequate.

8. **We now have to consider the loss from G to I. The pressure head at G is 14.2 ft of toluene (see paragraph 6 above). This pressure should not be excluded in the section. For the branch in question we have the following losses: (a) loss in 106 ft of pipe, (b) one elbow, (c) one tee, and (d) one valve (No. 2). The pipe diameter, if we use a velocity of 20 ft per sec, is calculated as follows:**

10 gal per sec = 1.34 cu ft per sec
Pipe area = 1.34/20 = 0.067
Equivalent diameter = 3½ inches I.D.

As before,

$$\text{i. } R_e = \frac{0.866 \times 62.3 \times 20 \times 3.5}{0.000396 \times 12} = 542000$$

$$f = 0.0018 + \frac{0.1526}{(542000)^{0.35}} = 0.0052$$

ii. From Equation (17)

$$\frac{P}{p'} = 0.0052 \times \frac{12}{3.5} \times 106 \times \frac{400}{2 \times 32.2} = 1.2 \text{ ft of toluene}$$

iii. The elbow loss will be the same as in 5iii above

$$\frac{P}{p'} = 0.6 \text{ ft of toluene}$$

iv. The loss through the tee, receiving 33% of the flow is obtained by Table 12 in terms of equivalent elbows and is roughly 9 elbows

$$\frac{P}{p'} = 9 \times 0.6 = 5.4 \text{ ft of fluid}$$

v. **The loss through a globe valve is obtainable from the values of K_{a1} for this fitting given in Table 12. Thus, for a fully open globe valve $K_{a1} = 0.19$, and as for the other valves**

$$\frac{P_{a1}}{p'} = 0.19 \times \frac{400}{2 \times 32.2} = 1.2 \text{ ft of toluene}$$

The total loss G to I is the sum of items (ii) to (v), so that

Loss GI = 1.2 + 0.6 + 5.4 + 1.2 = 8.4 ft of toluene

We have ample reserve of head and we may be able to use a 3-inch I.D. pipe although this is a matter of choice since the computations were made with a fully open gate valve at I, and a slight adjustment will give us precisely the flow desired.

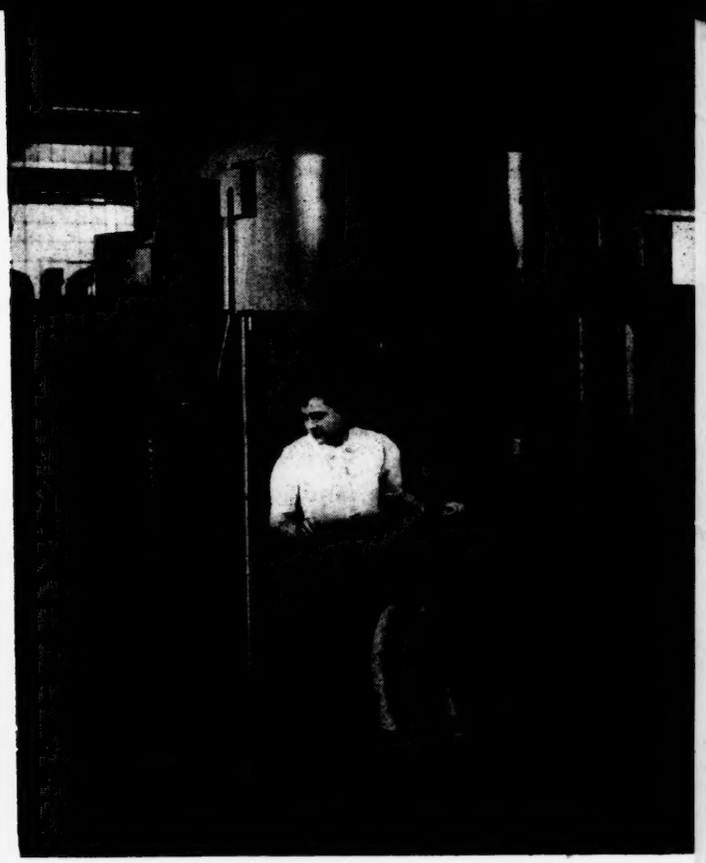
To summarize we have the following data:

PIPE

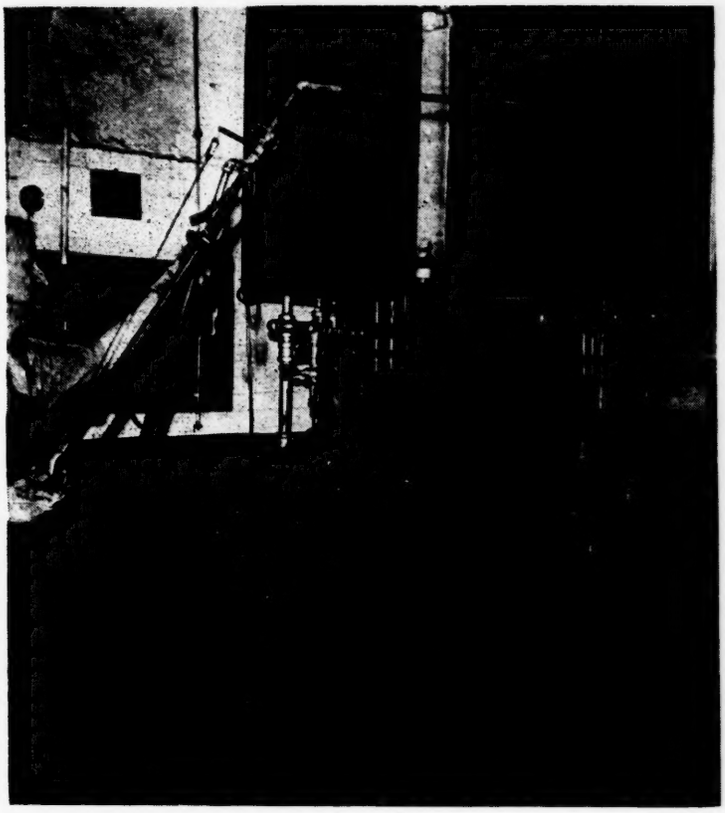
421 ft 5 inch I.D. pipe from A to G
165 ft 6 inch I.D. pipe from A to K
106 ft 3½ inch I.D. pipe from A to I
5 ft 5 inch I.D. long sweep elbows
1 ft 6 inch I.D. long sweep elbow
1 ft 3½ inch I.D. long sweep elbow
1 ft 6 inch × 6 inch × 3½ inch tee
1 ft 6 inch × 5 inch transition piece
1 ft 6 inch gate valve
1 ft 5 inch gate valve
1 ft 3½ inch gate valve

Welded connections throughout except at valves which will be flanged. Use nominal commercial pipe diameters having internal diameters nearest to these given.

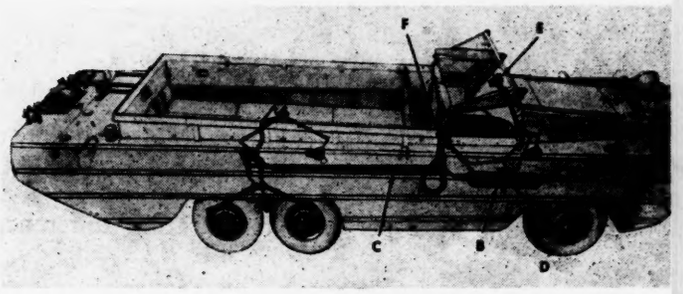
Picture Paragraphs



(Above) **Air-conditioned cab for traveling cranes developed by Cleveland Crane & Engineering Co. Enclosure is of shatter-proof, transparent plastic. Unit air conditioner controls dust, fumes, and temperature.**



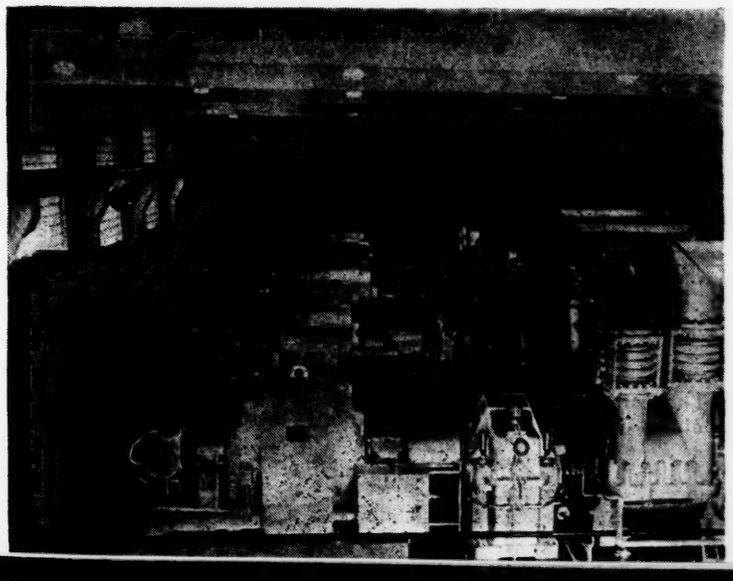
(Above) **Device for quick cleaning of boiler tubes shown by Compresed Air Institute photo. Pipe attached to shovel handle has disc attached at one end to dislodge soot while compressed air introduced at other end blows soot out. Chain controls air valve.**

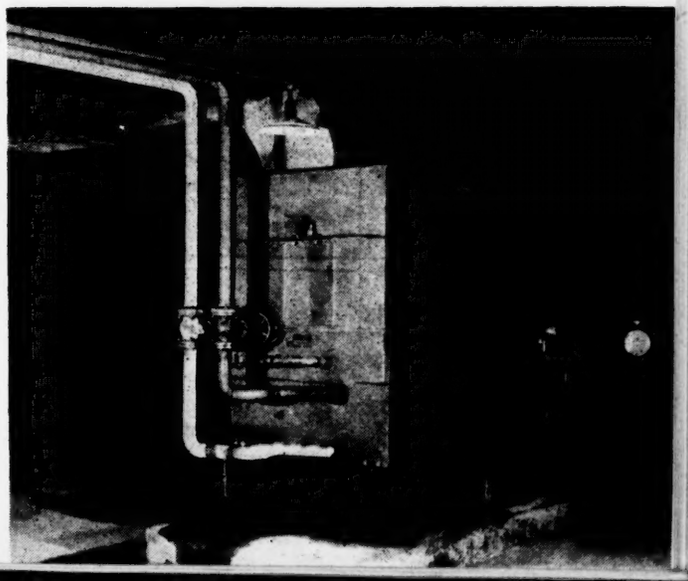


(Above) **Army "Duck" driver can inflate or deflate any or all tires while vehicle is moving or standing. Units of General Motors system are: (A) Air compressor; (B) Air storage tank; (C) Air lines; (D) Pressure joints on hubs; (E) Controls; (F) Valves for six tires.**

(Below) **Air speeds faster than the speed of sound are produced by five huge Carrier Corporation centrifugal compressors at the Wind Tunnel Laboratory of the Aberdeen Proving Grounds, permitting study of the behaviour of projectiles travelling faster than sound.**

(Below) **Nine million cubic feet of refrigerated storage space are cooled at famous WFA refrigerator-cave at Atchison, Kans., by 48 Niagara Fan Coolers. Brine at 20F is supplied by three compressors rated at 250 tons each.**





Heat Flow in Panel-Heated Rooms

R. G. VANDERWEIL
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Readers who have followed the discussion of various radiant heating problems in previous articles of this series by Mr. Vanderweil may have been looking for information on the relationships between such variables as panel temperature, unheated wall temperatures, wall heat loss, air temperature, and loss by ventilation. In the accompanying article the author shows these correlations, explains the heat balance, develops its theory, and concludes with a simple graphical method of determining temperatures and heat quantities for a typical room.

BEFORE taking up the subject of heat flow in a room, a review of the principles of heat flow by conduction, convection, and radiation seems in order to simplify later computations.

Conduction: Fig. 2 shows a rod of a cross-sectional area of A sq ft and a length of L ft. If the conductivity of the rod is designated by k and given in Btu/sqft,°F,hr/ft, the heat flow Q_c, by conduction increases with the conductivity k, with the cross sectional area A, and with the difference of temperature between the points 1 and 2 $(t_1 - t_2)$. The heat flow decreases with increasing length L, so that we can express the heat flow by conduction as

$$Q_c = A\left(\frac{k}{L}\right)(t_1 - t_2) \quad \ldots\ldots (1)$$

where $\frac{k}{L}$ is the unit conductance or heat flow through a unit area per unit temperature difference, $\frac{Ak}{L}$ is the total conductance per unit of temperature difference, and $(t_1 - t_2)$ is the temperature difference.

Flow Resistance: The reciprocal of conductance is the resistance to the flow of heat; for Fig. 2 this is $\frac{L}{kA}$ and for a section of unit area it is $\frac{L}{k}$.

If heat flows through resistances in series, the individual resistances may be added to obtain the total resistance. For example, in the outside wall of a building with an *outside* film conductance of f and with heat flowing from the *inner surface* of the wall to the outside air, the total resistance of the unit area m is the sum of the resistances of the wall and the outer film coefficient, or

$$m = m_1 + m_2 = \frac{L}{k} + \frac{1}{f}$$

The total conductance, representing the reciprocal of the total resistance, is then:

$$U = \frac{1}{L/k + 1/f} \quad \ldots\ldots (1a)$$

and the heat flow may be computed by the formula:

$$Q = A\,U\,(t_a - t_o) \quad \ldots\ldots (1b)$$

where A is the area, t_a the inner wall temperature, and t_o the outside air temperature.

Convection: Transmission of heat from one medium to another is called *convection* if one of the media is in a moving state as in, for example, heat flow from a radiator to moving air. If the moving medium is circulated by gravity (that is, by the change of its own specific gravity due to the heating process), heat is transferred by *natural* convection. Tests have shown that natural convection conforms to laws which may be expressed by an equation somewhat similar to equation (1):

$$C = c\,A\,(t_1 - t_2) \quad \ldots\ldots (2)$$

Where C is the heat flow by convection from surface to air in Btu per hour; c the "film conductance" by convection, or the unit flow of heat through an area of 1 sq ft and with a temperature difference of 1F; t_1 the temperature of the warmer and t_2 the temperature of the cooler medium, and A is the area of contact of the two media.

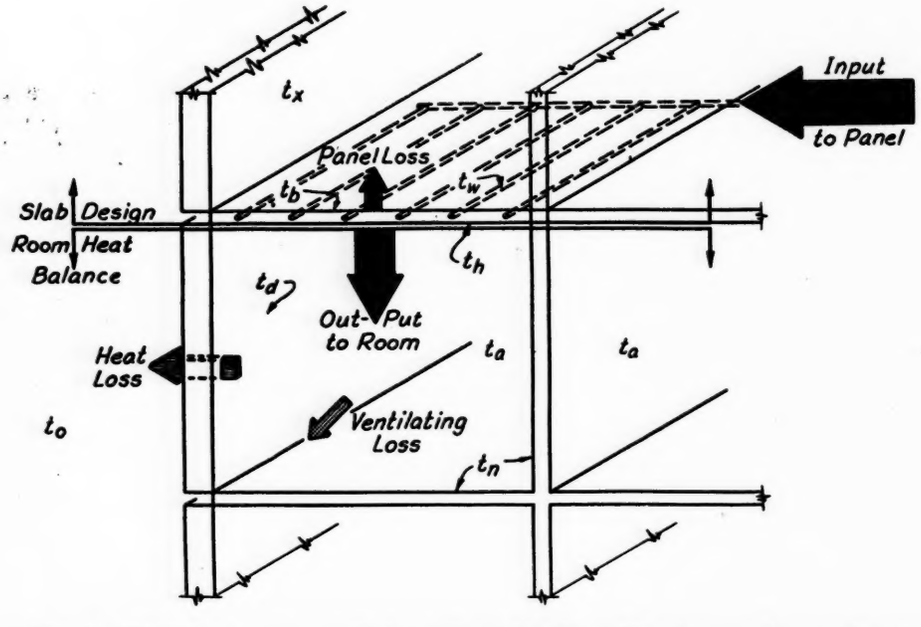


Fig. 1. Heat flow components in radiant heating. The temperatures shown are defined in the list of symbols.

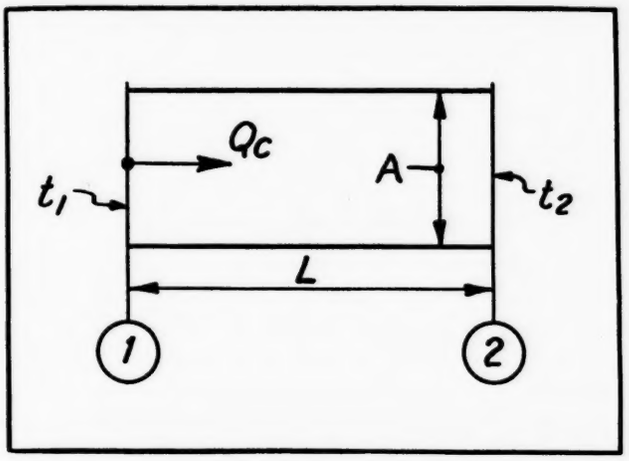


Fig. 2. Diagram illustrating flow of heat by conduction through a rod.

It should be noticed that the convective film conductance c is not a constant as was the conductance $\frac{k}{L}$ of equation (1) but, due to greater flow velocities generated by greater temperature differences, increases with $(t_1 - t_2)$; also the film conductance changes with the location of the heated surface, whether floor, wall or ceiling. See Fig. 3.

Radiation—Special Case. Radiation may be defined as the direct transmission of heat through space. Sunlight and stellar light are received by radiation, and heat can be transmitted according to the same principles. Let us first consider an area A_h of temperature t_h (see Fig. 4) entirely enclosed by an area A_2 at the temperature t_2. For this special case, radiation may be expressed as:

$$R = r A_h (t_h - t_2) \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where R is the heat flow by radiation in Btu per hr; r the "film" conductance by radiation in Btu per sq ft per F per hr; A_h the hot area in sq ft, and t_h and t_2 temperatures, deg Fahr, as shown in Fig. 4. The radiant "conductance" r is not a constant, but varies with the temperatures of A_1 and A_2 as shown in Fig. 5. The radiant conductance also depends upon the emissivity of areas *1* and *2;* the emissivity, however, may be considered essentially constant for all materials (except polished metals) used in rooms and approximated by 89% of black body emissivity. Fig. 5 is based on this approximation.

The surface conductance f given in handbooks is nothing but the combined film conductances r and c (or $f = r + c$) by assuming the temperature t_2 in Fig. 4 and equation (3) to be identical with the temperature t_2 of equation (2).

Radiation in Free Space. In Fig. 6 the area A_1 at temperature t_1 loses heat by radiation to a space of temperature t_2 and an area A_2 also at a temperature of t_2. The total hourly heat lost by area A_1 equals:

$$R = R_a + R_{1,2} + R_b$$

The heat in Btu per hour radiated to area A_2 equals $R_{1,2}$. Obviously the amount of heat received by A_2 is governed not only by A_1, t_1 and t_2 but also by the geometric construction of the entire system (that is, size of A_1, A_2, mutual distance, angle a, etc.). The heat transmitted from A_1 to A_2 can then be expressed as:

$$R_{1,2} = F_{1,2}\, r_{1,2}\, A_1 (t_1 - t_2) \quad \ldots\ldots\ldots\ldots (4)$$

where $F_{1,2}$ is named "form" or "shape" factor and expresses the ratio: Heat radiated from A_1 to A_2 divided by the total heat lost by A_1:

$$F_{1,2} = \frac{R_{1,2}}{R_a + R_{1,2} + R_b} \quad \ldots\ldots\ldots\ldots\ldots (5)$$

The fraction of heat radiated by A_1 and received by A_2 may be computed if $F_{1,2}$ is known. Computation of this value is complicated, but has been performed by various authors and presented in graphical solution. Fig. 7 shows one of these solutions and covers the case of two adjoining areas at an angle of 90°.

The influence of the form factor (geometric relation between heated and unheated surface) is great. Kalous[1] computed and plotted the primary radiation of a heated ceiling to walls and floor of a cubicle as shown in Fig. 8. It may be seen that appreciably more heat is radiated to the upper parts of the walls or center parts of the floor, and thus, that the various parts of wall and floor must be of different temperatures. Practically, due to convection and secondary radiation, these differences are small.

Division of Problem

Consider a radiant heated room with ceiling panel as shown in Fig. 1. Hot water supplies heat to the

[1]K. Kalous, General Theory of Radiant Heating, 1937.

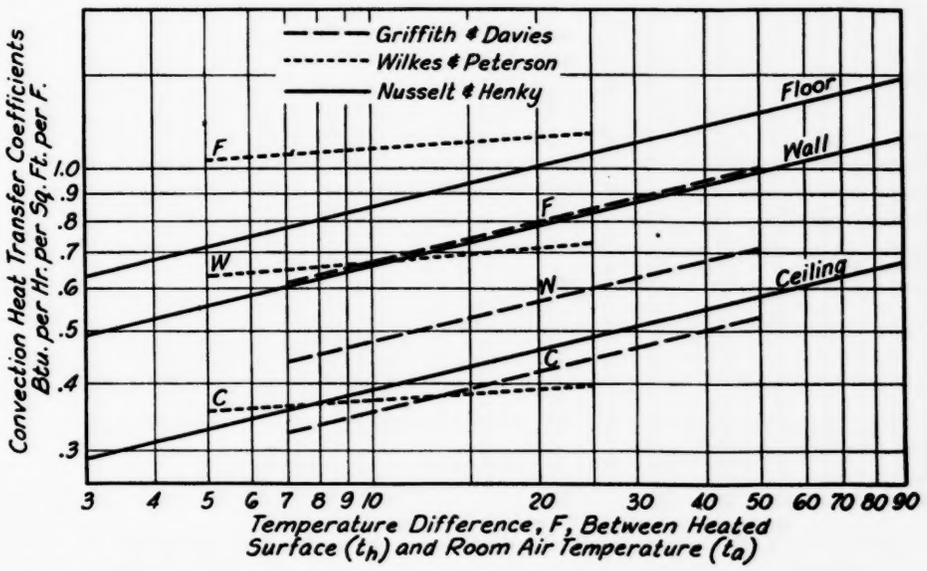


Fig. 3. Unit film conductance (heat flow by convection) for various temperatures of room air and room enclosure as determined by various investigators. It is suggested to use the data plotted in the solid curves from Nusselt and Henky.

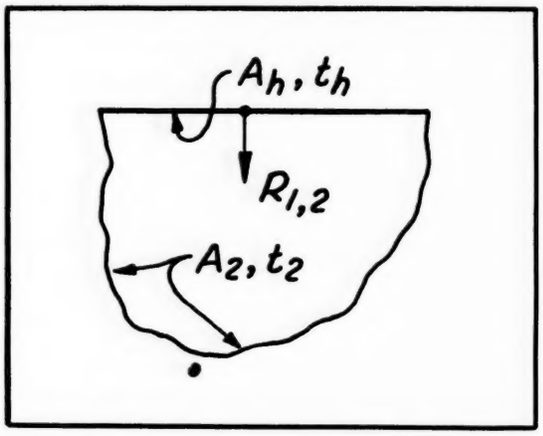


Fig. 4. All radiation emitted by the area A_h is transmitted to and received by the area A_2.

panel coil; this is the heat input to the panel. This heat is transmitted partly through the ceiling surface below the panel, while the remainder of the heat supplied is dissipated by the floor surface above the panel, the latter being a loss. The heat supplied to the room through the ceiling is partly lost through the outside wall (heat loss), and partly dissipated by heating the air circulating through the room.

In order to simplify discussion of the problem, the heat dissipated through the ceiling will be covered as one phase, that through the floor above as another phase. Referring to Fig. 1, heat flow above the panel is designated as "slab design", the flow below by "room heat balance" or "room heat flow". This article is concerned with the room heat flow only; a subsequent installment will treat with the slab design.

Room Heat Balance

Any panel heated room is enclosed by three kinds of surface: Heated, dissipating, and neutral enclosures. The heated surface supplies the heat required; the dissipating enclosures (outside wall and glass) lose heat to the surrounding space (outside); and the neutral enclosures, such as interior walls between two heated rooms, neither lose nor supply heat.

Fig. 9 indicates the various components of heat flow in a room heated by a ceiling panel. Heat, $(Q + Q_v)$, is supplied to the ceiling surface (waved lines) by *conduction;* and from the surface heat is transmitted by *radiation* (R_1) directly to the dissipating surface, by *radiation* (R_2) to the neutral enclosures, and by *convection* (C_a) to the room air. The neutral enclosures have no heat losses and for this reason reflect their entire influx (R_2) to the outside wall by radiation (R_3), and to the room air by convection (C_b). The room air loses part of the heat supplied (C_a and C_b) to the outside wall (C_c) and the remaining heat is lost by ventilation (Q_v).

Symbols Referred to in Room Heat Balance

t_h = Temperature of heated panel surface.
t_w = Water or tube temperature.
t_2 = Mean surface temperature of all unheated room enclosures (unheated MRT)
t_n = Mean surface temperature of neutral (unheated or uncooled) enclosures.
t_d = Mean surface temperature of dissipating (outside or cooled) surfaces.
t_b = Temperature of opposite surface of heated panel.
t_a = Room air temperature.
t_x = Temperature of air in space adjoining opposite side of panel.
t_o = Outside air temperature.
t = See MET.
Q = Heat lost through dissipating (outside) surfaces.
Q_v = Heat supplied to ventilation air.
q = Heat output of panel per unit area.
R_1 = Heat lost by radiation from heated surface to dissipating surfaces.
R_2 = Heat lost by radiation to neutral (interior) surfaces.
R_3 = Heat lost by radiation from neutral to dissipating surfaces.
R = Total heat lost by a heated surface by radiation.
r = Unit radiation coefficient.
r_{hd} = Unit radiation from heated to dissipating surfaces.
r_{nd} = Unit radiation from neutral to dissipating surfaces.
C_a = Heat lost by convection from the heated surface to air in the enclosure.
C_b = Heat lost by convection from the neutral surfaces to air in the enclosure.
C_c = Heat lost by convection from air in the enclosure to dissipating surfaces.
C = Total heat lost by heated surface by convection.
c = Unit convection coefficient.
A = Area.
A_h = Area of heated surface.
A_n = Area of neutral surfaces.
A_d = Area of dissipating surface.
F = Form, shape or angle factor.
F_{hd} = Angle factor, heated to dissipating surfaces.
F_{nd} = Angle factor, neutral to dissipating surfaces.
MRT = Mean radiant temperature; the weighted (by areas) average of t_n, t_d, and t_h; that is, the mean of the temperatures of all of the enclosing surfaces.
D = Depression of t_a below MRT, that is, $MRT - t_a$.
MET = Mean effective temperature; also referred to as t, the mean of the air temperature t_a and the temperatures of all *unheated* enclosing surfaces, t_2.
CT = That room temperature at which, in a hypothetical room of zero depression D, the human occupants feel comfortable. For standard humidity conditions CT has a range of several degrees.
U = Conductance of dissipating surface; heat transmission coefficient.
i = Number of air changes per hour.
V = Volume of enclosed space, or room.
c_p = Specific heat of air.

Fig. 9 is based on the assumption that outside wall and glass, both of known transmittance, may be replaced by a dissipating enclosure of average transmittance, and that the various points of the surface of all neutral enclosures are of approximately equal temperature. Surface conductances have to be selected accordingly. A discussion of this figure will prove helpful in finding the mutual relationship between the temperature of the various room surfaces and the air temperature.

For any given room and outside conditions, as well as panel surface temperature, the resistance to the flow of the various components of heat (R and C of Fig. 9) are given and cannot be changed. The actual resistance against the flow by convection is, for any convective flow component:

$$\frac{1}{cA} \qquad \text{(2a)}$$

according to equation (2), and to the flow by radiation:

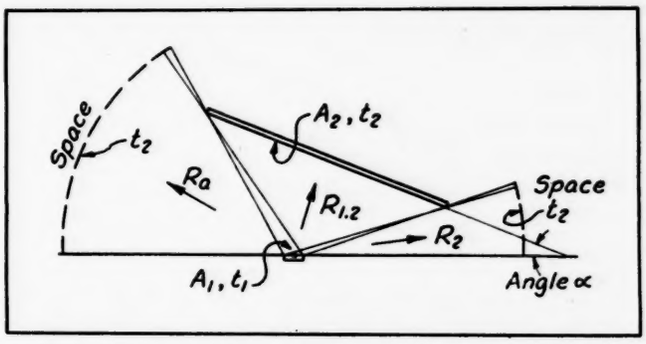


Fig. 6. Part of the radiation emitted by area A_1 is received by area A_2. The balance is lost to the space.

$$\frac{1}{FrA} \qquad \text{(4a)}$$

according to equation (4).

Since c, r, A and F are all given if the room dimensions, the comfort and outside temperatures are known, the individual resistances are given and constant for each room.

The significance of the foregoing statement may be explained by using a water flow analogy. In this analogy, the temperatures of the heat flow problem conform to heights in the water flow system. The resistance against the flow of water is given by the cross-section and length of the water channels and the water flow may be compared to the heat flow. Disregarding the heat flow components R_1 and Q_v, the system in Fig. 9 is replaced by the system in Fig. 10 showing several open water channels of known resistance. The height h_h conforms to the value $(t_h - t_o)$ of Fig. 9, where t_h is the temperature of the panel surface and t_o the outside temperature. If water is supplied at elevation h_h it will divide between the individual troughs, and the amounts flowing through each will be indirectly proportional to its resistance. Since the resistance of each trough (R_2 and R_3, C_a, C_b, and C_c) is given, the elevations h_n and h_a are also fixed and known. Now, h_n and h_a conform to t_n, the temperature of the neutral surfaces, and t_a the air temperature of the heated room, so that we can state that: In a given room, not only the ratio (flow by radiation ÷ flow by convection) but also the temperatures t_n and t_a are fixed.

Since the room's mean radiant temperature (MRT) is a mean of all room surface temperatures, there is also a fixed ratio between the room air temperature and the MRT. The difference $D = (MRT - t_a)$, also called "depression", *is set for any given room* and cannot be selected freely by the designer.

For this reason, the conception, so frequently met, that in radiant heated rooms the air temperature may be de-

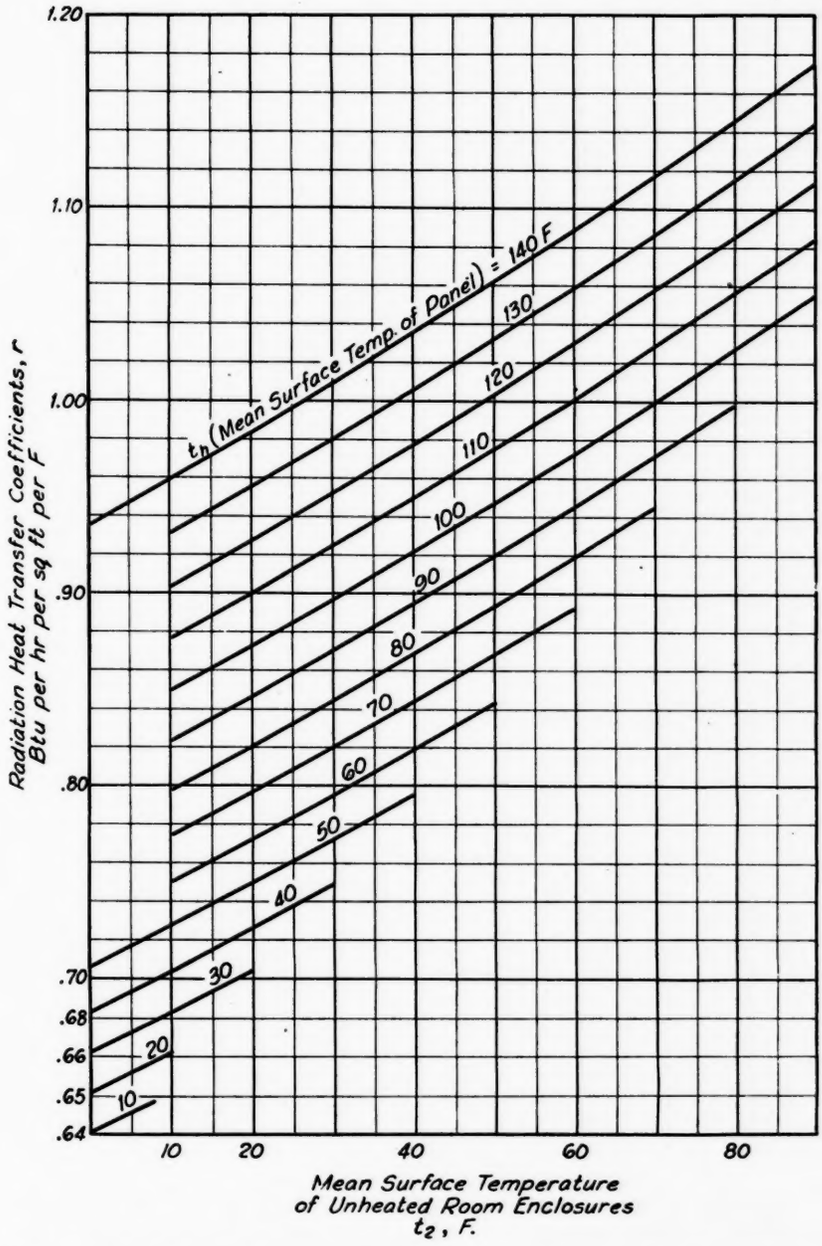


Fig. 5. Unit heat transfer coefficients for radiation. For an arrangement shown in Fig. 4, the heat output can be computed by multiplying the coefficient by the temperature difference $(t_h - t_2)$ and the area of the hot surface.

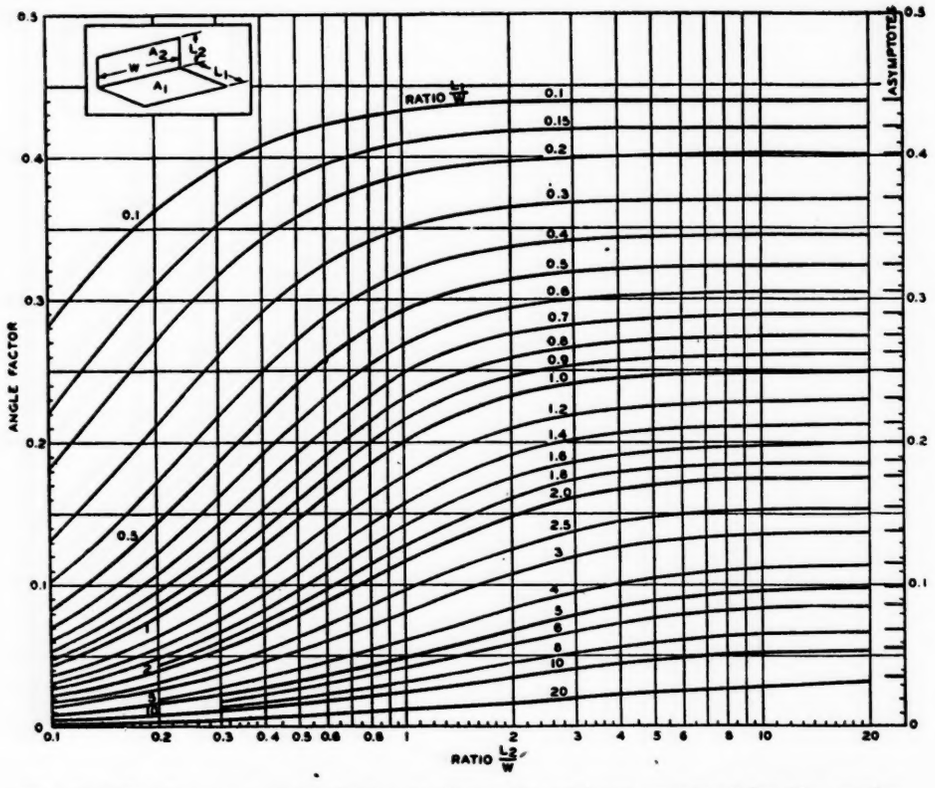


Fig. 7. The form or angle factor is the ratio of heat received by the cooler area to the heat radiated by the warmer area to the cooler area *and* space. This chart, covering angle factors for adjoining surfaces at 90° to each other, is one of a series by Mackey, Wright, Clark and Gay of Cornell University.

pressed to any desired value, is erroneous. Actually, this depression is relatively small and scarcely amounts to more than 5F in dwellings (MRT = 72.5, $t_a = 67.5$). *D* decreases in poorly insulated structures and with the use of weather stripping.

As mentioned, Fig. 10 did not take into account the ventilation loss ($Q_v = O$) and thus applies to a room with natural ventilation. The air leakage was included in the room heat loss computation. If forced ventilation is used in the system, the conditions deviate appreciably from those shown in Fig. 10; in fact, the supply of large amounts of cool air is the only means of providing extremely low room air temperatures in combination with a high MRT, which may be desirable in hospitals or other rooms requiring special temperature conditions, and will enable the engineer to design for any desired depression.

Finally, Figs. 9 and 10 may be used to prove the increased heat output by radiation in ceiling heated rooms.

According to Fig. 3, the value of *c* decreases if the panel is "moved" from the floor to ceiling and thereby the resistance to heat flow by convection is increased. The trough C_a of Fig. 10 becomes narrower and less heat flows through the convection channel. With the flow in the radiation trough constant, the ratio (radiation output) ÷ (total output) has increased.

Theory of Room Heat Flow

Various authors have investigated the problem of room heat flow. In Europe, rather complete rational equations were published by van der Held[2] but were not used extensively. In the United States, Profs. Raber and Hutchinson have carried out considerable research work and developed rational equations.[3] All theories, in order to result in usable equations, must include certain simplifying assumptions for a number of surfaces such as constant film conductance *c* (compare Fig. 3); *r* (compare Fig. 5); constant surface temperatures of entire wall surfaces (compare Fig. 8), etc. These rational equations, furthermore, are necessarily involved and require the solution of as many as seven simultaneous equations.

Consequently, the author has developed a simplified rational method for determining room heat flow. This method is applicable to all cases; even so, it is not practicable for simple projects, such as residences, etc., and for most ordinary buildings the simple graphical method presented at the close of this article is sufficiently accurate. The simplified rational method, which follows, is suggested for rooms where a large depression is desired, where unheated air is supplied for ventilation, and similar special cases.

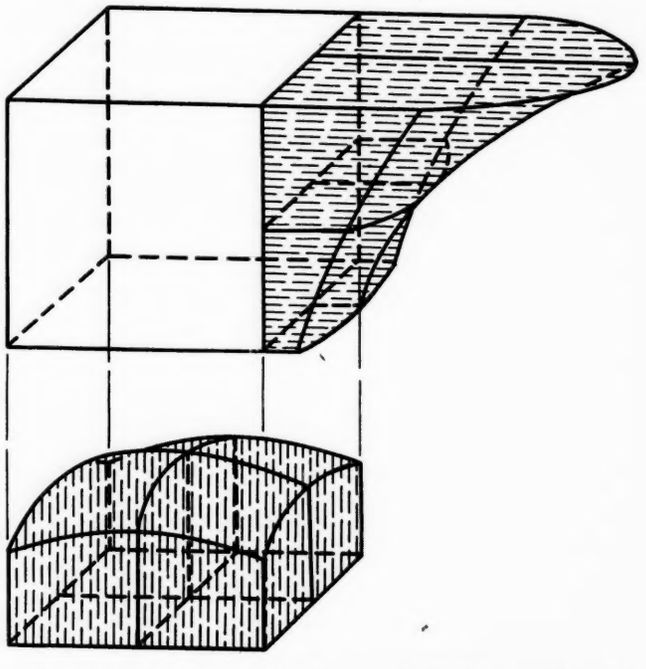


Fig. 8. Projection indicating radiation quantities at various points in a cubicle with a heated "ceiling". The projection at the bottom shows the relative magnitude of primary radiation received at the floor. The projection at the right shows the relative magnitude of primary radiation received by various points of the wall.

[2]Heat Transfer by Radiation in Ceiling Panel Systems, *Gesundheits Ingenieur*, 1939.

[3]Panel Heating and Cooling Analysis; Trend Curves for Estimating Panel Heating Systems, *American Society of Heating and Ventilating Engineers Journal.*

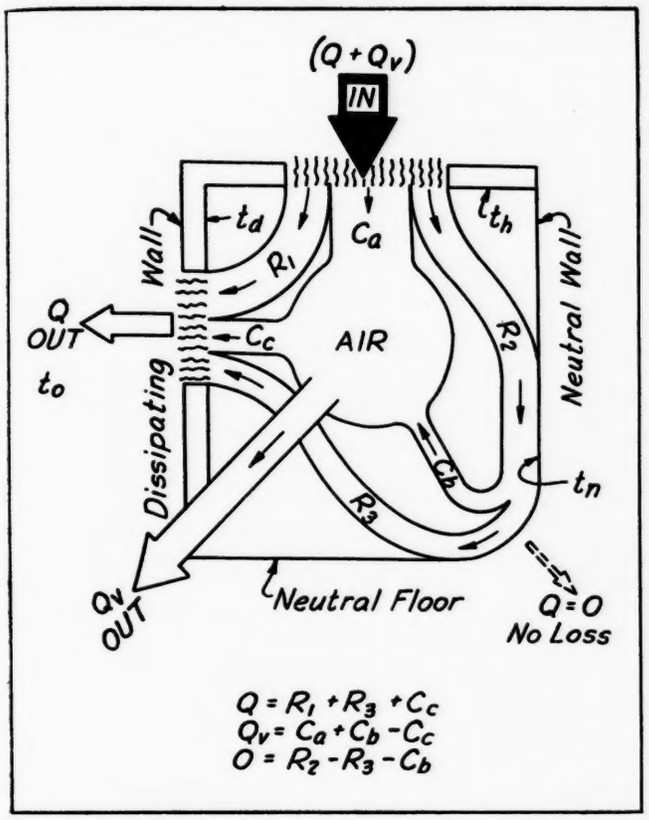


Fig. 9. In a radiant heated room, heat is supplied to the panel. The panel surface loses heat by radiation *(R)* to other room surfaces and by convection *(C_a)* to room air. Ultimately all heat lost to the room is lost through outside walls, *Q*, and by ventilation *(Q_v)*.

Considering Fig. 9, several flow equilibria may be stated:

The heat influx into the outside wall is equal to the sum of heat supplied, $R_1 + R_3 + C_c$. Furthermore, if the temperature of the inside surface of this wall is designated by t_d, the heat loss by conduction (see waved lines in dissipating wall) through this wall may be expressed in terms of equation (1b) and must equal the heat influx:

$$Q = R_1 + R_3 + C_c = UA_d\,(t_d - t_o) \quad (6)$$

where values of *R*, the radiation components, are computed according to equation (4); *C* is the convection component of the heat flow computed according to equation (2); *U* is defined by equation (1a); A_d is the area of the dissipating surface, t_d its inner temperature, and t_o the outside temperature.

The ventilation loss must equal the hourly air change in cubic feet multiplied by the heat supplied per cubic foot but also according to Fig. 9:

$$Q_v = C_a + C_b - C_c = iV\,(t_a - t_o)\,c_p \quad (7)$$

where the values *C* represent the various convection components of Fig. 9; *i* the number of air changes per hour; *V* the volume of the room in cubic feet; and $(t_a - t_o)$ c_p the heat supplied per cubic foot and c_p the specific heat of air in Btu per F per cu ft. Finally, the equilibrium state at the neutral wall may be expressed by:

$$R_2 = C_b + R_3 \quad (8)$$

That is, all heat absorbed by this wall is reflected to the air and outside enclosures.

If we finally define the mean radiant temperature as the weighted mean of the various temperatures t_h, t_n, t_d of the various enclosures of area A_h, A_n and A_d or

$$MRT = \frac{t_hA_h + t_nA_n + t_dA_d}{A_h + A_n + A_d} \quad (9)$$

we have four equations which may be solved for the three surface temperatures t_h, t_n, t_d and the number of air changes *i* required to obtain the desired temperature depression $D = (MRT - t_a)$.

Procedure of Computation

It has been found that comfort exists not only where the *MRT* and air temperature are alike and equal to the *CT*, but also in rooms where the *MRT* exceeds the *CT* by the same number of degrees as the *CT* exceeds the air temperature.

For example, if a depression *D* of 20F is desired, and a comfort temperature of 68F is required, the *MRT* and t_a can be determined as follows:

$$MRT = 68 + \frac{D}{2} = 78F$$

$$t_a = 68 - \frac{D}{2} = 58F$$

With these temperatures known, all others, as well as the hourly air change may be computed as follows:

When substituting the values for *R* and *C* in equations (6), (8) and (9) we obtain:

$$MRT\,(A_h + A_n + A_d) = t_h A_h + t_n A_n + t_d A_d \quad (9)$$

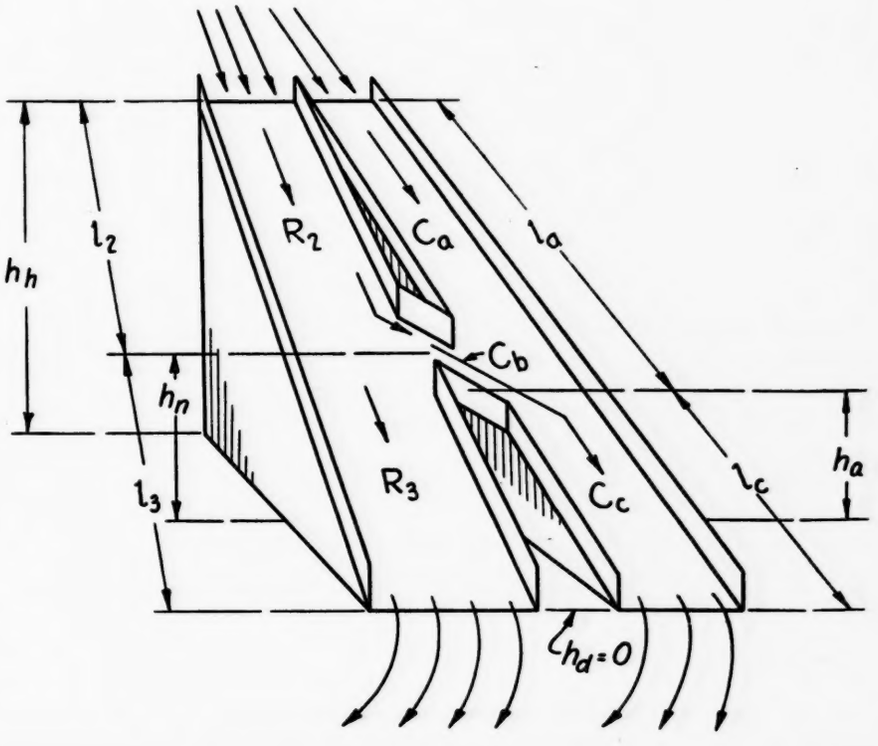


Fig. 10. Hydraulic analogy to Fig. 9.

$$UA_d\ (t_d - t_o) = r_{hd}\ F_{hd}\ A_h\ (t_h - t_d) + r_{nd}\ F_{nd}\ A_n\ (t_n - t_d) + cA_d\ (t_a - t_d) \quad \ldots\ldots (10)$$

$$0 = r_{hn}\ F_{hn}\ A_h\ (t_h - t_n) - r_{nd}\ F_{nd}\ A_n\ (t_n - t_d) - c_n A_n\ (t_n - t_a) \quad \ldots\ldots (11)$$

In equations (10) and (11), the various form factors F may be taken from curves similar to those shown in Fig. 7.

In the foregoing we have three simultaneous equations to be solved for three unknowns — t_h, t_n, t_d.[4]

With all temperatures known, the number of hourly air changes is now computed by the formula:

$$i = \frac{(t_h - t_a)\ c_h A_h + (t_n - t_a) c_n A_n + (t_d - t_a)\ c_d A_d}{(t_a - t_o)\ Vc_p} \quad \ldots (12)$$

where V is the room volume in cubic feet.

The fact should be stressed that, when using this method, the room heat loss can not be computed according to standard heat loss methods, but must be figured from equation (6), $Q = UA_d\ (t_d - t_o)$ once the temperatures t_d and t_o are computed. The heat loss by ventilation is figured from equation (7) and is: $Q_v = iV(t_a - t_o)\ c_p$. The total room heat requirement is then $(Q + Q_v)$.

Recapitulating the theory of room heat flow, the following may be stated: For given room dimensions and room heat loss, there is a definite relationship between the MRT and room air temperature t_a. The heating engineer can not design for a "desired" depression (for example, a room temperature of 70F; MRT = 78F, t_a = 62F, D = (78 — 62) = 16F) unless he supplies cold air to the room and computes the number of air changes required per hour. With natural ventilation D varies within narrow limits, usually $2F < D < 7F$.

For standard conditions use the graphical solution as described in the next section.

If greater depression is desired and forced ventilation is provided, the procedure of calculation is as follows: Assume D. Compute MRT = CT + D/2; t_a = CT — D/2.

With MRT and t_a known, compute next, t_h, t_n and t_d by equations (9) to (11). Finally compute the hourly air change by equation (12), and Q and Q_v by equations (6) and (7).

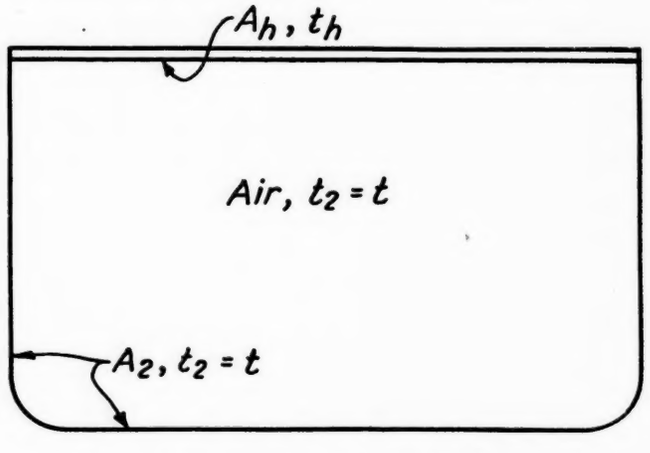


Fig. 11. Assumptions for simplified method.

Approximate Graphical Solution

Inspection of equations (9) to (12) will show that even the simplified rational solution is too cumbersome to be used for standard layouts and for this reason the following method is presented. It may be used as an approximation to compute rooms with natural ventilation or rooms supplied with fresh air at a temperature equal to that of the room air temperature.

When discussing the room heat balance (Fig. 9) and its flow analogy (Fig. 10) it was pointed out that there is a definite and fixed relationship between the various wall surface temperatures and the room

[4]A method of solving these equations is given in the "Chase Radiant Heating Manual."

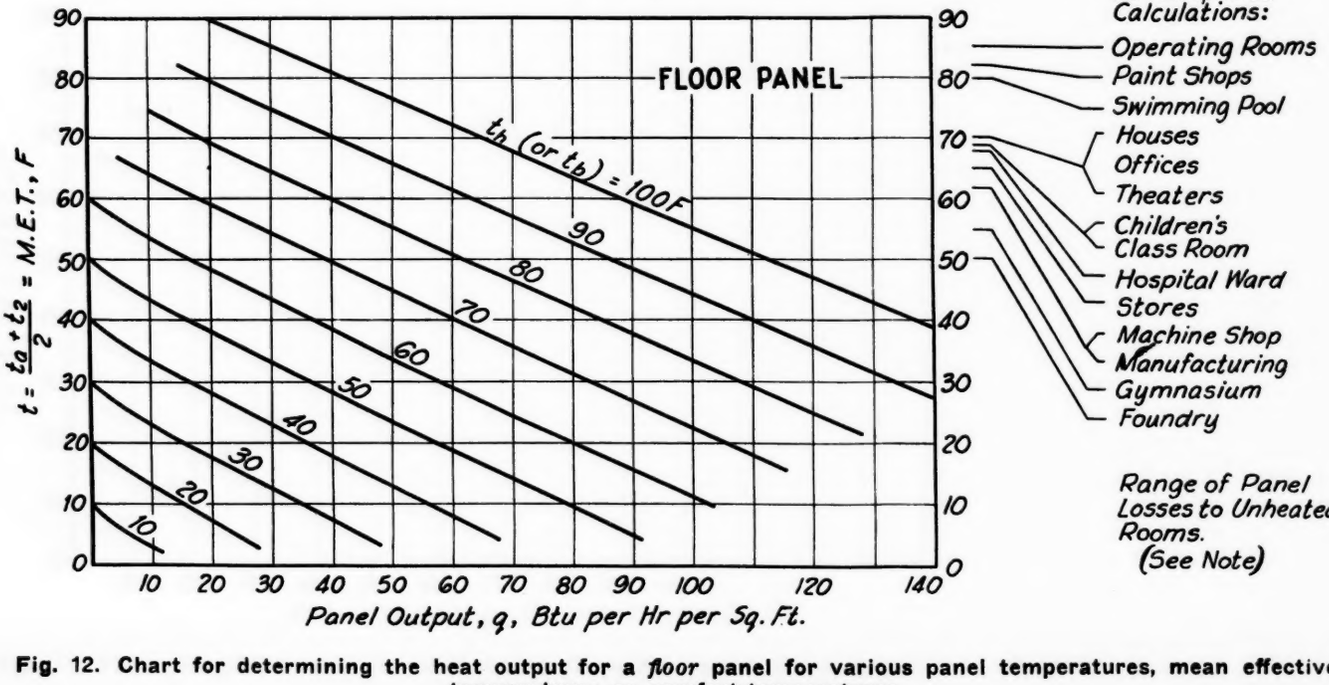


Fig. 12. Chart for determining the heat output for a *floor* panel for various panel temperatures, mean effective temperatures or comfort temperatures.

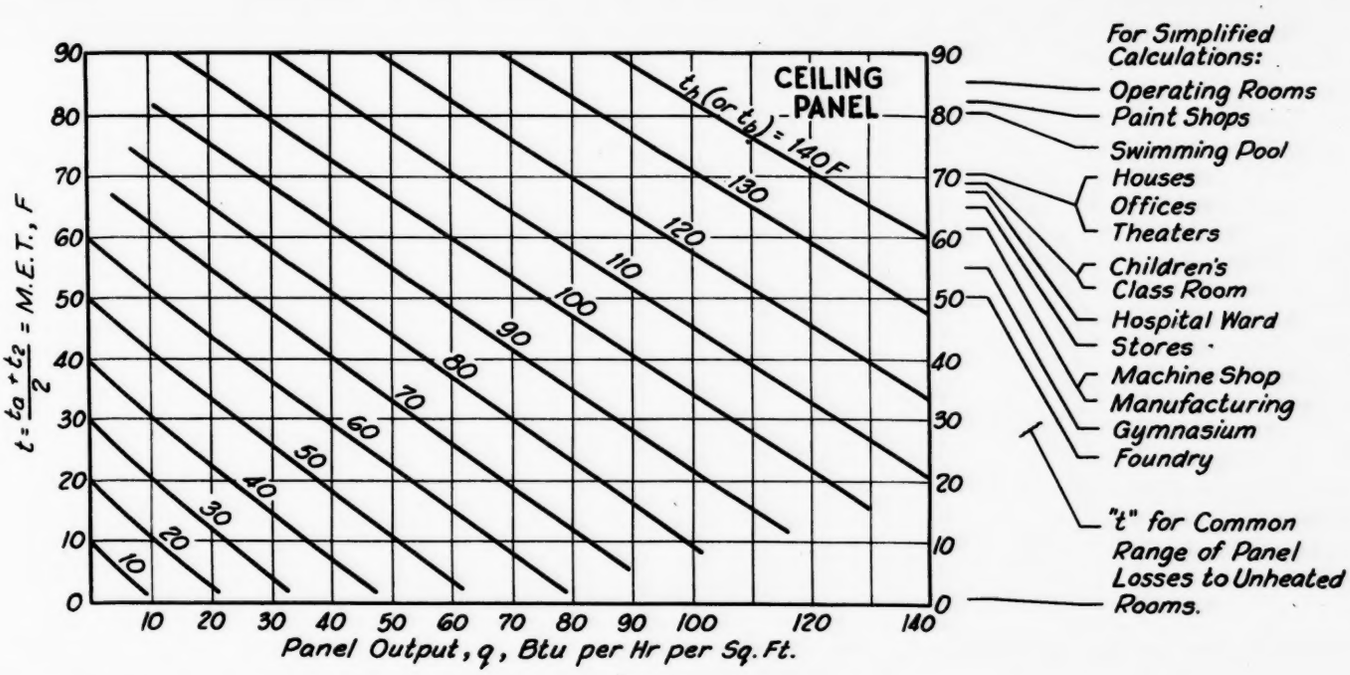


Fig. 13. Chart for determining the heat output for a *ceiling* panel for various panel temperatures, mean effective temperatures or comfort temperatures.

air temperatures. Numerous tests, computations and practical installations have pointed to the fact that in rooms of natural ventilation the mean temperature of all unheated surfaces (t_2) and the room air temperature (t_a) differ by only a few degrees, and both are generally slightly lower than the comfort temperature. If it is assumed that t_2 and t_a are equal to the comfort temperature ($t_2 = t_a = CT$) not only highly conservative values will be obtained but also the computation work connected with deriving the panel output will be reduced to a minimum.

For these assumptions the room may be represented by Fig. 11, where the panel is entirely enclosed by an area A_2 of temperature t_2 and by air of same temperature $t_a = t_2$, and we may now state: $CT = t_a = t_2 = MET$. For this reason the radiation output according to equation (4) reduces to equation (3) and may be combined with the convection output, equation (2). The total panel heat output is then:

$$Q = C + R = cA_h (t_h - t) + rA_h (t_h - t), \text{ or}$$
$$Q = (c + r)(t_h - t) A_h \quad \ldots\ldots\ldots\ldots (13)$$

The output per unit area of panel is then:

$$q = (c + r)(t_h - t) \quad \ldots\ldots\ldots\ldots (14)$$

and may be readily found for ceiling, wall and floor by combining Figs. 3 and 5.

To simplify calculations for actual installations, equation (14) has been solved graphically for floors and ceilings; Fig. 12 shows the solution for floors, Fig. 13 for ceilings.

Referring to Fig. 12, and using the right hand scale, assuming CT = MET, it will be found, for example, that for a room of a CT of 65F and a floor panel at 90F (t_h), the panel output $q = 52$ Btu per sq ft per hr.

For a building with a large glass area, it may be advisable to assume the temperature of the unheated surfaces (t_2), and the air temperature (t_a) and hereby MET, according to the left scale of Fig. 12, rather than assuming that MET = CT. For example, a machine shop with large glass area heated to CT = 65F may have a relatively low t_2 of, say, 50F. If the air temperature t_a is assumed to be relatively high, in order to compensate for the low temperatures of the room's surfaces, say 70F, then, according to the left scale of Fig. 12

$$MET = \frac{50 + 70}{2} = 60F$$

For an MET of 60F and a t_h of 90F, the graph shows q = 62 Btu per sq ft per hr, 19% higher than the value of 52 found by the previous method. The error in practice arising from previous assumptions is largely corrected by using the "slab design graphs" (to be described in a subsequent installment), and reducing said error of assumption from 19% to about 6%. It should be noted that whenever the table on the right-hand side of Fig. 12 is used instead of the equation $MET = (t_a + t_2) \div 2$

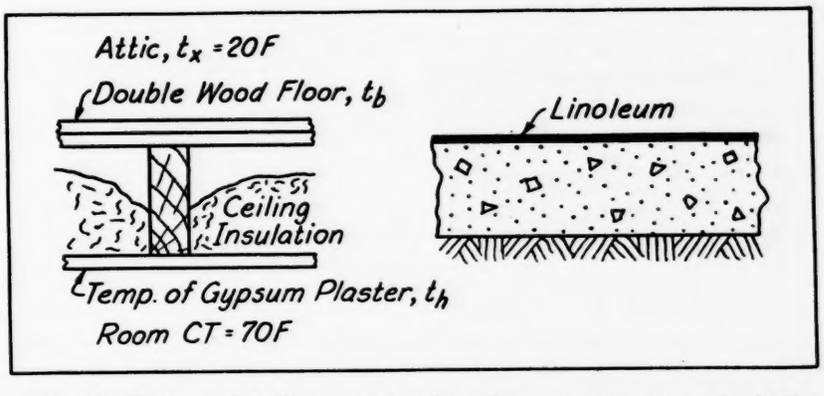


Fig. 14. Floor and ceiling construction for example, plan of which is shown in Fig. 15.

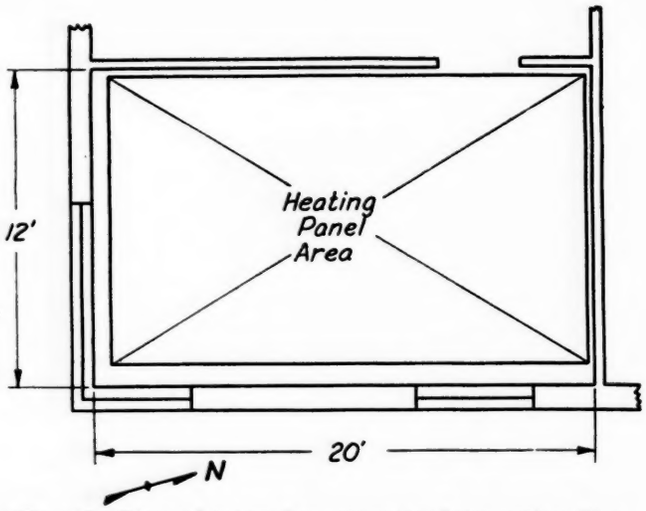


Fig. 15. Plan of room for example, floor and ceiling construction for which is shown in Fig. 14.

of the left-hand scale the results will be more or less conservative.

Use of Graphs – Recapitulation

For dwellings, and similar conventional installations, use the right-hand temperature scale of Figs. 12 and 13, assuming MET = CT. For buildings of large glass area, compute *MET* according to the equation on the left-hand scale of Figs. 12 and 13.

Sample Calculation

In order to explain the use of the graphs a panel heated room will be computed. The panel size will be found first in the following paragraphs; tube distance and diameter, water temperature, and panel heat loss for the same example will be calculated in a subsequent article.

A corner room with the plan shown in Fig. 15 is assumed; ceiling and floor structure are as shown in Fig. 14. Heat requirements of the room are rather large, 12,000 Btu per hr, and for this reason the entire ceiling or floor area—with exception of a small strip around the outside walls — should be covered by the heating panel. Ceiling area 240 sq ft. Available for heated panel is an area of 200 sq ft to supply the 12,000 Btu per hr. The required unit output is then:

$$q = \frac{12{,}000}{200} = 60 \text{ Btu per sq ft per hr}$$

According to Fig. 12, right-hand scale, in a room of t = 70F MET, the output of a floor panel of 90F is 41 Btu per sq ft per hr and since 90F presents an absolute maximum for the floor temperature, a floor panel can not cover the full heat requirement of the room. For this reason a ceiling panel is selected. From the ceiling panel sizing chart, Fig. 13, find that for a room of 70F a panel of a surface temperature t_h = 109F, delivers 60 Btu per sq ft per hr. This temperature is reasonably low and a ceiling panel of the size 11 x 19 ft = 200 sq ft may be selected. Its mean surface temperature is 109F; its internal structure will be discussed in the final installment.

Atmospheric Corrosion of Iron

The rate of atmospheric corrosion is dependent upon the: (1) length of time moisture is in contact with the surface, (2) extent of pollution of the atmosphere, and (3) chemical composition of the iron or steel. Certain alloying elements promote the formation of a more dense, adherent and, hence, protective rust, which retards further attack. Thus steel containing 0.1-0.2% copper has its atmospheric corrosion resistance increased from 1.5 to 4 times depending upon the location. Similarly phosphorus itself (over 0.05%) has a beneficial effect but it is especially noticeable in the presence of copper. This explains the comparatively excellent showing of Bessemer copper steels.

Test for Service

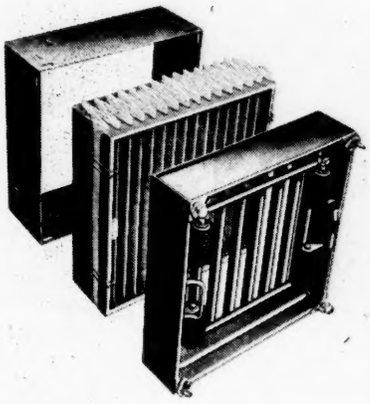
While economic reasons limit the practical addition of suitable alloying elements, data show that relatively small amounts of many elements by themselves, and more often with others, confer appreciable atmospheric corrosion resistance upon steels. It is, however, necessary to test such steels in the type of atmosphere to which they will be exposed to determine suitability, since resistance to one type of atmosphere does not necessarily mean acceptable service in another. Further, it should be noted that the effects of various alloying elements are not always cumulative, although there are many instances where such additive properties are observed. The phosphorus-copper effect noted above, applied in the presence of certain other alloying elements.

Under standardized conditions of test many combinations of alloying elements in steels produce rust films which improve the corrosion resistance appreciably over that of copper steel. To reduce corrosion losses below the minimum found for certain low alloy corrosion resistant steels, it is necessary to add alloying elements in amounts disproportionate to their value. This is due to the fact that, under standard test procedure, a loss of weight of about 6.5 grams per square decimeter of most alloy steels is used up in supplying metal for a protective oxide film. Therefore, at atmospheric corrosion rates shown by certain low alloy high strength steels now on the market are about the optimum that can be obtained economically in this type of steel.—*C. P. Larrabee, Research Laboratory, Carnegie-Illinois Steel Corp.*

NEWS OF EQUIPMENT AND MATERIALS

Electro-Airmat

NAME—Electro-Airmat.
PURPOSE—Electronic air filter combined with Airmat filter so that when power is off for any reason there is still protection against dust due to stack effects in air conditioning systems.
FEATURES—Collector element is electrostatically charged Airmat paper. Airmat is cellulose product composed of a number of plies of porous tissue-like sheets formed of short cellulose fibers in "jack-straw" arrangement.



When electrostatic charge is applied to Airmat paper, plies tend to separate and each individual fiber becomes a collecting electrode which attracts and holds dust and smoke particles. Full height ionizers reduce electrical losses due to fewer wire ends. Arrestance rating of unit, when tested by the discoloration method, is 90% or better with atmospheric dust and smoke. This efficiency is obtained at the normal velocity of 35 fpm and standard rating of 1,000 per unit. Ease of installation, economy and convenience of maintenance are advantages of unit. No water connection, sewer drains, or water-tight duct construction are necessary. Filter weighs 40% less than electronic filters having metal plate collectors and requires 30% less floor area. When Airmat paper has accumulated its dust load, it is removed and replaced with clean material by turning a crank in a mechanical loader which automatically folds paper into serrated base section of filter unit. For small installations requiring only a few units, a manual loader answers the purpose. Airmat paper is said to be a highly efficient mechanical filtering medium so that when power is off it stops dust.
MADE BY—*American Air Filter Co., Inc., First and Central Ave., Louisville 8, Ky.*

Steel Valve

NAME—Kitson steel bar-stock valve.
PURPOSE—Flow control for high pressure lines.
FEATURES—Valve has carbon or

stainless steel body with stainless steel stem. A feature of this valve is that even when the valve is fully opened and under pressure, the stuffing box can be repacked readily. Can be used for high pressure lines handling air or any liquid.
MADE BY—*The Kitson Co., 1500 Walnut St., Philadelphia 2, Pa.*

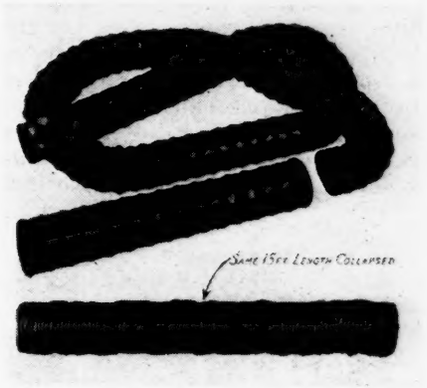
Preheater

NAME—Rempe Hot-Spot bulk tank preheater.
PURPOSE—For preheating heavy liquids such as oil and tar in bulk storage.
FEATURES—Preheater is made to fit any size tank having a manifold 16½ in. or larger and provides 38 sq ft of direct radiation surface plus 10 sq ft of secondary shell heating surface. It has a flow accumulator which makes it necessary for the liquids to flow over the coils before entering the suction line. The coil is 1½ in. standard steel pipe, the shell is 12 gauge sheet steel. Accumulator is of steel construction bolted in place. At the time of fabrication, the proper size inlet and outlet pipes can be provided for steam or hot water heating.

MADE BY—*Rempe Co., 342 N. Sacramento Blvd., Chicago 12, Ill.*

Ventilating Hose

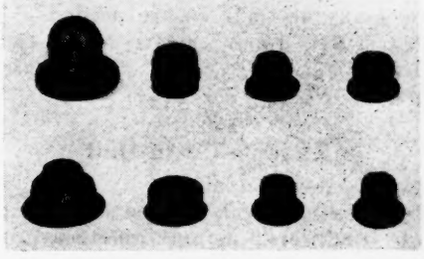
NAME—Portovent.
PURPOSE—To meet the needs for a large diameter which can be compressed into small space for shipping and which can run around bends.
FEATURES—Reinforcement consists of rings spaced from 2 to 5 in. apart according to the diameter of the hose. Both the inside and outside of the hose are covered with a neoprene base compound. Sections, which come in lengths from 2.5 ft up, can be readily coupled and uncoupled. There are special attachments for coupling the hose to blowers or other



air handling apparatus.
SIZES AND CAPACITIES—Comes in sizes from 5 to 24 in. diameter. Compression for packing is 6 to 1 overall.
MADE BY—*American Ventilating Hose Co., 15 Park Row, New York 7, N. Y.*

Pipe Plugs and Caps

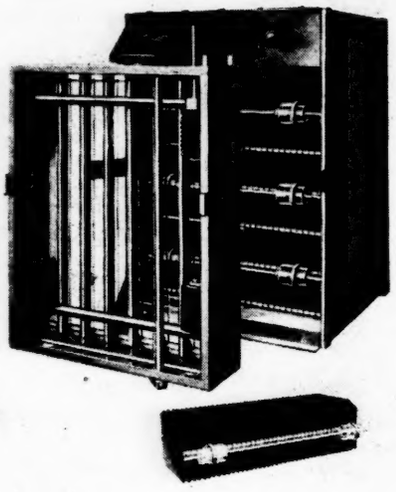
NAME—Protecting pipe plugs and caps.
PURPOSE—To employ a new stamping method for turning out threaded parts such as pipe caps.
FEATURES — Manufacturing process eliminates machining and results in the stamping of precision plugs and caps for pipe protection. At present, they are made with NPT threads in sizes up to 1 in., fabricated from



steel or aluminum. It is said that larger sizes will soon be available. Process was formerly used for turning out airplane parts.
MADE BY—*Tubing Seal-Cap, Inc., 215 W. 7th St., Los Angeles, Calif.*

Electro-Cell

NAME—Electro-Cell.
PURPOSE—Unit type electronic air filter with removable collector plate assemblies for easy cleaning.
FEATURES — Positive and negative collector plates are assembled on cross rods to form horizontal groups which are easy to handle and may be readily removed from filter casing. This makes possible innovations in construction that simplify installation, improve performance, and assure better maintenance. Sliding into filter casing in same manner as a desk drawer, plate assemblies can be removed to adequate sewer and drain connections for cleaning and re-oiling at a convenient time if a spare set of plates, sufficient for one section, is kept on hand. By using this spare set as replacements, length of time filter is out of service is reduced to minimum. Ionizers of filter extend full height of sections, thus reducing electrical losses by having fewer ionizer wire ends. Construction of the sections is such that



duplication of top and bottom sections of box-like units is eliminated when the application calls for assembling one upon another.
SIZES AND CAPACITIES—Standard sections are 2 ft and 3 ft in width with capacity of 1000 cfm per unit. Capacities range from this minimum to as many sections as are needed.
MADE BY—*American Air Filter Co., Inc., First and Central Ave., Louisville 8, Ky.*

Reverse-Cycle Unit

NAME—Reversatemp.
PURPOSE—A reverse cycle heat pump air conditioner using a refrigerating unit for both heating and cooling, and intended for homes, offices, hotels and similar applications.
FEATURES—Self-contained unit, fitting into a 3½ x 5 x 7 ft space.
MADE BY—*Drayer-Hanson, 738 E. Pico Blvd., Los Angeles 21, Calif.*

Vertical Motor

NAME—Vertical dripproof motor.
PURPOSE—For vertical fan or pump installations, etc.
FEATURES—This is a vertical, dripproof, a-c motor with a 15% service factor, designed for operation from 50 or 60 cycle, 3- or 2-phase circuits at all standard voltages. At present a NEMA "B" flange type mounting up to and including the "284" frame and a NEMA "C" face type mounting up to and including the "326" frame are available. All ventilating openings are shielded against the en-

trance of dripping liquids or falling particles. Use of the company's centrifugal bearing seal permits the use of softer grease for better lubrication and longer bearing life. The Alucast rotor, with bars, fans and end rings cast in one operation from aluminum alloys, is used. Coils are protected with Vinylastic insulation.
MADE BY — *Crocker-Wheeler Div., Joshua Hendy Iron Works, Ampere, N. J.*

Refractory for Boilers

NAME—Zircoat-M refractory.
PURPOSE—To provide a dense surface that will withstand high furnace temperatures.
FEATURES—This zirconium silicate base material is applied with a spray gun and sets rapidly. Makers claim that a coating of this material has increased the continuous operation of marine boilers and has increased the life of brickwork in furnaces of the aluminum industry. Claimed to protect brickwork exposed to severe flame impingement and corrosive action of clinker or fly ash.
MADE BY—*Basic Refractories, Inc., 845 Hanna Bldg., Cleveland, Ohio.*

Attachment for Welding

NAME — Thinweld attachment for light gauge welding.
PURPOSE—Device to make possible welds from 10 amperes to the maximum rating of the welding machine.

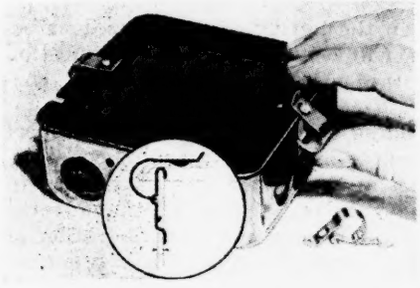
FEATURES—By plugging the jack into the low, medium or high positions of the jack, it is possible to obtain 3 additional ranges of amperage. Intermediate points can be obtained by the field rheostat. In the first range, the 3-step Thinweld permits lower amperage for light gauge welding. The other two ranges give the operator the amperage required for the welding of heavy gauge metals.
MADE BY—*The Hobart Bros. Co., Hobart Sq., Troy, Ohio.*

Condenser Cleaner

NAME—Oakite Airefiner No. 52.
PURPOSE—A special chemical cleaner for the prevention of hard lime scale on coils and the control of slime and algae on surfaces of evaporative condensers and evaporative coolers.
FEATURES—Due to lime-solubilizing properties, compound holds lime in suspension and helps prevent the formation of hard lime scale deposits on coil surfaces. It is claimed to have effective germicidal and fungistatic properties. Concentrations recommended for use are non-toxic. The cleaner is a white powder that is readily soluble in water. Solutions and powder are odorless.
LITERATURE AVAILABLE—A 4-page special service report describes its applications.
MADE BY—*Oakite Products, Inc., 58A Thames St., New York 6, N. Y.*

Box Cover Fastener

NAME—Spring steel fastener for box covers.
PURPOSE—An easy means for fastening box covers such as knock-out boxes without the use of tools.
FEATURES—Clip for holding the cover is snapped by hand into pre-



punched holes in the sides of the box. By flipping the clips into locked position the cover is held firmly in place. Details of clip are shown in the illustration. To remove the cover, the clips are snapped back with the thumb.
MADE BY—*Timmerman Products, Inc., 2010 Fulton Rd., Cleveland 13, Ohio.*

Germicidal Lamp

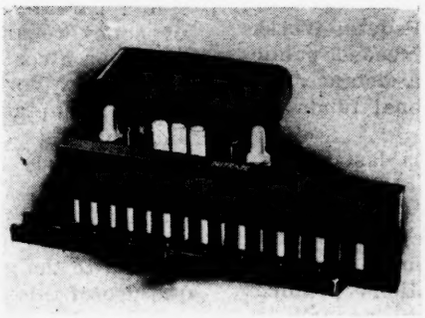
NAME—Germicidal lamps.
PURPOSE—For destroying airborne bacteria.
FEATURES—Two types are offered in 15 and 30 watt sizes. Type A is suitable for school rooms, homes, dairy barns, hospitals, and the sterilization of drinking glasses. Type B is suitable for meat storage refrigerators, air conditioning ducts, food packaging, and other operations where there is air turbulence or other provision for protection of workers against the higher ozone output of Type B lamps. Lamps are arranged to prevent direct viewing by the naked eye. Both types of lamp are rated at 2,500 hours life.
MADE BY—*Sylvania Electric Products, Inc., Salem, Mass.*

Eye Shield

NAME—Willson FeatherSpec.
PURPOSE—For use in semi-hazardous work such as spot welding and light grinding.
FEATURES—Shield has a one-piece plastic lens which is gripped tightly in a suspension lockframe. A slight pull releases the lens from the grooved metal frame and makes it possible to substitute a green lens for the clear lens when the work involves glare. Shield can be worn over prescription lenses.
MADE BY—*Willson Products, Inc., Reading, Pa.*

Nitrate Comparator

NAME—Taylor-Betz nitrate slide comparator.
PURPOSE—For determining nitrate concentration of boiler feed water.
FEATURES—Set consists of a pH slide comparator base with a color standard slide with 9 standards • representing 0, 10, 20, 30, 40, 50, 60, 80 and 100 ppm of NO_3, 5 small test



tubes, graduate, beaker, pipette, and reagents. The slide can be used on any Taylor pH or phosphate comparator base. The accuracy of the method of nitrate determination is not affected by ions normally present in boiler water.
MADE BY—*W. A. Taylor & Co., 7300 York Rd., Baltimore 4, Md.*

Flow Meter

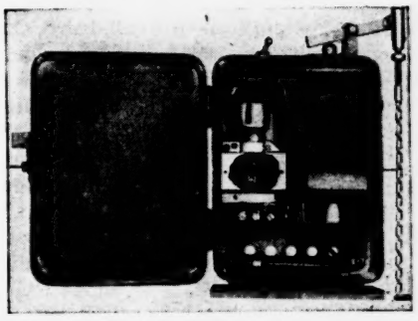
NAME—Rotasleeve.
PURPOSE—For the measurement of large flows of liquids and gases.
FEATURES—A metal sleeve which fits into standard pipe tees, sizes 3 in. and up. V-port flutes designed with the greatest area at the top are built in to offer variable flow area for fluid passage. The flow enters the bottom of the Rotasleeve causing the flow indicating float to move upward. Fluid passes through the V-port flutes with the float assuming a position in direct proportion to the actual rate of flow.
LITERATURE AVAILABLE—Bulletins 82-A and 83-A.
MADE BY—*Fischer & Porter Co., 9747p County Line Rd., Hatboro, Pa.*

Glass Insulation

NAME—Improved Foamglas insulation.
PURPOSE—For use in industrial buildings and equipment.
FEATURES—The new product has 10,000,000 cells per cu ft as against 5,000,000 for the old product. The value of K for the original Foamglas was 0.45 Btu per hr per sq ft per degree F per in. (conductivity at 50F) and for 300F, 0.70. Similar values for the improved product are respectively 0.40 and 0.55.
MADE BY—*Pittsburgh Corning Corp., 632 Duquesne Way, Pittsburgh, Pa.*

Electric Idling Device

NAME—FW-1400 mercury type idling device.
PURPOSE—To shut down the gasoline engine to idling speed shortly after the operator has stopped welding.
FEATURES—To bring the engine to normal welding speed, the operator strikes an arc. The idling device and governor are linked with the throttle so that the device can close the throttle without having to resist the governor action. A mercury switch closes instantly but has a 15 second delay in opening. When weld-



ing stops, the mercury time delay switch remains closed for 12 to 15 seconds and then opens up to operate and close the throttle to idling position. Switch is totally enclosed and is sealed under a pressure of hydrogen gas.
MADE BY—*The Hobart Bros. Co., Hobart Sq., Troy, Ohio.*

Parts Cleaner

NAME—Turco Fuzee.
PURPOSE—Compound for cold water tank immersion cleaning of engine parts, such as pumps, pistons, etc.
FEATURES—Solvents used have been improved by increasing the wetting action. A compound has been added

which floats as a seal to prevent obnoxious fumes from the solvents.
A metal dip rack has been developed that fits the standard 5-gal container to provide a simple means for cleaning small parts by immersion.
MADE BY—*Turco Products, Inc., 6135 S. Central Ave., Los Angeles 1, Calif.*

NEWS OF THE MONTH

CONSTRUCTION and CONTRACTORS FACE THE PEACE

Public works, private enterprise, cost-plus, and lump-sum are prominent in construction's post-war lexicon.

• **PUBLIC WORKS.**—President H. A. Dick of the Associated General Contractors of America points out that applications by local governments to the Federal Works Agency for loans to complete plans of needed public projects prove the value of this form of assistance and the need for the appropriation of additional funds for this purpose.

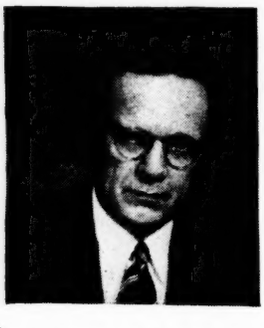
Of $17½ million provided by Congress last spring, FWA had, as of August 31, approved loans totaling about $4¼ million, he said, and for 14 of the more populous States, applications pending were more than enough to exhaust their allocations. This means, he added, that subsequent applications from those States, where the early starting of projects is undoubtedly most urgent, will have to be held in abeyance for lack of funds.

H. A. Dick

The appropriation of additional funds to aid state and local governments in completion of plans for needed public projects was among the recommendations which President Truman has made to Congress. Other recommendations include the starting of the postwar Federal-aid highway program, enactment of the Federal-aid airport program, and the releasing of funds for war-deferred public projects of all kinds. Mr. Dick urges prompt action by Congress on the President's recommendations for expediting construction.

A survey recently completed by AGC indicates that general contractors are prepared to handle greatly expanded operations as rapidly as materials and manpower become available. With the industry now operating at an annual rate of less than one-third capacity, it was feared that disintegration might have occurred which would hamper quickly expanded operations. Although much worn out equipment will need replacement as fast as new equipment is available, the AGC survey shows that construction operations can be started again without delay once the letting of contracts starts.

• **PRIVATE ENTERPRISE.** — Mr. Dick says further, "We also agree with the President's contention that public works projects should not compete with private industry for materials and manpower. Private construction should come first, but it is not necessary to delay unduly the starting of certain public works projects that are indispensable to the health and general welfare of the nation.



Raymond M. Foley

Another proponent of private enterprise in construction is Commissioner Raymond M. Foley of the Federal Housing Administration, who declared in a New York speech last month that private enterprise is counted upon to provide the great bulk of the nation's postwar housing need—variously estimated at a million to a million and a half new dwellings a year for 10 years.

"But," says Mr. Foley, "The public, with its great need pressing upon it, now wants to know—does private enterprise propose to attack the whole housing field, or only some of the easier and more quickly profitable parts thereof?"

• **COST-PLUS.**—When the letting of contracts does begin, apparently there will be two sides to the question of policy regarding the postwar continuation of contracts on a cost-plus-a-fixed-fee basis.

The New York Building Congress has issued a report on the cost-plus-a-fixed-fee and other types of construction contracts. A special committee was authorized to make a study of the subject because of the adverse criticism with regard to the use and administration of the cost-plus-a-fixed-fee contract on wartime construction. It was thought that the criticisms might be misleading to the general public and perhaps prejudicial to the use of this type of contract on postwar work.

It was the consensus of the committee that the cost-plus-a-fixed-fee contract had served the country during the war as no other form of contract could have done under the circumstances. Further, in its discussion of the fixed-fee basis as a postwar possibility, the committee says there are reasons for its use other than for speed alone. The fixed-fee lends itself to work where it is necessary to carry on certain planning during the course of construction. Such contracts are also used where the work is indeterminate and where lump sum bids would reflect a very high cost in order that the bidder may protect himself against possible loss. Obviously, says the committee, the desirability of the fixed-fee contract versus the lump-sum contract will vary inversely with the ability of the architect and/or engineer.

• **LUMP SUM.**—Secretary Joseph C. Fitts of the Heating, Piping and Air Conditioning Contractors National Association believes that the lump-sum form of contract will return to its almost exclusive position in postwar construction. Mr. Fitts has high praise for the work done in construction on the cost-plus-a-fixed-fee basis during the wartime emergency, but he points out that this form of contract has little to recommend it in a peacetime economy. The element of time saved by starting work before plans are completed is almost the only advantage of the cost-plus-a-fixed-fee contract, in addition, of course, to the time saved by piling in excess labor and overtime. In peacetime, however, construction is a capital investment, well planned in advance, upon which the incentives of economy and competitive opportunity must be brought to bear if costs are not to reach prohibitive proportions. Once the engineering work on a given project has been done and specifications drawn up, says Mr. Fitts, there is no reason why a competent contractor can not make an equitable bid in competition with the field.

Joseph C. Fitts

• **CONTROLS END.** — Government restrictions on the building of homes, public works, and commercial structures are lifted as of October 15 by the withdrawal of WPB Order L-41.

To encourage construction and at the same time to minimize the possibility of inflationary demand, a six

point program is described by John W. Snyder, Director of War Mobilization and Reconversion. The program includes inter-agency action to break bottlenecks, prevent hoarding of materials, counteract inflationary pressure, discourage excessive and unsound lending on mortgages, increase materials production, and provide an advisory service on home values for prospective buyers. Commenting on the outlook, Mr. Snyder said: The rapid expansion of the construction industry can be the greatest single source of jobs in our entire economy.

• **BUT.**—In apartment centers like Manhattan, prospective builders say that continuance of OPA ceilings on residential rents will discourage large-scale apartment construction.

• **WAGE UNCERTAINTY.**—A fly in the construction ointment was made realistically evident when all bids on building of New York City's Merriman Dam were rejected by the Board of Water Supply because they contained contingency items ranging from three to eight million dollars to cover unpredictable labor costs. Announcing the board's decision, Irving Huie, president, said that to let contracts with such contingency clauses would increase the cost of the work to the city out of all proportion to its true value.

• **SUPPLIES.**—A favorable straw in the wind of available materials is the Department of Commerce announcement that millions of dollars worth of plumbing supplies are included as a part of the $200 million in surplus goods for sale by the Office of Surplus Property. Many of the items declared surplus by the services have been in short supply for a long time, according to William S. Bradley, director of the OSP.

In offering this merchandise to the trade on a national basis at fixed prices, officials of the OSP feel that they have reached an equitable solution to the problem of balance between general supply on one hand and protection of business on the other. It is the purpose of the program, says Mr. Bradley, to move the merchandise as quickly as possible and without any dislocation of the regular market.

• **PRODUCERS' COUNCIL.**—While the lifting of WPB restrictions on home building removes a major obstacle in the way of reviving residential construction, the building industry faces two additional problems which must be solved before the housing shortage can be eased materially, according to L. C. Hart, president of the Producers' Council, national organization of manufacturers of building materials and equipment.

"First, the OPA must adopt a realistic policy toward the pricing of building products and, second, the construction industry must be given assurance that plans for the controlling prices of new homes will be abandoned," Hart said.

QUICK RECONVERSION

Refrigeration industry has few reconversion problems but is held up by lack of material.

• **CONVENTION.**—To overcome the lack of material and supplies, the major problem that is holding up the reconversion of the refrigeration industry, the Refrigeration Equipment Manufacturers Association has arranged a convention at Hot Springs, Va., October 15-17. It will meet with government officials to see if some means can be found for expediting the industry's change-over to peacetime schedule.

• **SPEED ESSENTIAL.**—Extensive major retooling delays are not necessary, as far as machinery and equipment are concerned. As one of the association's directors pointed out, it is commonly known that European countries and Great Britain are promising delivery of civilian items to South America which American industries cannot ship at this time without a license from the government.

• **INDUSTRY SHOW.**—The board of directors of REMA announced that it will resume its annual all-industry refrigeration and air conditioning show. The 1946 show will be held in the Municipal Auditorium, Cleveland, Ohio, October 28 to November 1. About 250,000 sq ft of floor space will be available, which will be sufficient for about 250 separate exhibits. This means that the coming show will be about three times larger than any show that was held prior to the war.

MORE ABOUT FUEL

Few clouds remain on fuel supply horizon.

• **STRIKE.**—As strikes spread among 250,000 workers in the oil industry, a fuel shortage was imminent in Detroit where Standard Oil and Texas Company storage plants were shut down. Union officials, however, assured an adequate supply for public utilities, hospitals, and other essential users.

In the meantime, oil worker strikes threatened to stop the flow of about 40% of the oil refined products coming to the Atlantic seaboard. By drawing on storage, supplies can be maintained for a time, but oil executives warn that a prolonged shut down would result in Eastern shortages.

With winter coming on, the situation is further complicated by the fact that distribution regulation, Directive 59 of the PAW, through which all oil products available for the east coast were commingled and pro-rated among consumers, is ended as of midnight September 30.

The fuel outlook was not brightened by a foremen's strike in the bituminous coal fields of Pennsylvania and West Virginia which, on Sept. 26, had shut down 77 mines with a daily production of 168,000 tons. The union is the United Clerical, Technical and Supervisory Employes of the Mining Industry, an affiliate of District 50, UMW.

• **BLACK MARKET.**—Oil Heat Institute calls attention to the reported fact that a rush to change from coal to oil heat in the New York area has resulted in a black market in the sale and installation of equipment.

This rush to convert has been occasioned by public utterances concerning the plentiful supplies of oil and the probability or at least possibility of limited supplies of anthracite.

• **EXPORT.**—In addition to the proposed shipment of six to eight million tons of bituminous coal to Europe (H&V, Sept. '45) about 350,000 tons of anthracite were being shipped to Italy during September, according to an Anthracite Industries report from the Foreign Economics Administration.

• **REGULATION.**—The ability to export anthracite and the urging by Frank W. Earnest, Jr., president of Anthracite Industries, Inc., that remaining government regulations on distribution of home heating fuels be lifted point to a marked easing of supplies of this class of fuel.

"The action of the SFA in removing restrictions on consumer deliveries is a step in the right direction," said Mr. Earnest at a meeting of retail coal dealers, "but it does not go far enough. The anthracite industry is confident it can assume responsibility for its customers this winter and therefore feels the remaining restrictions on shipments from producers to dealers should be eliminated immediately."

The anthracite supply outlook is better than it has been for some time, stated Mr. Earnest, and he anticipates it will continue to improve during the fall and

winter under the impetus of returning miners and improved mining equipment.

At the same time, Mr. Earnest promised early introduction on a commercial scale of a new type of anthracite-burning household heating unit (H&V, Sept. '44) radically different from and more efficient than present equipment. This new unit is called the Anthratube and is undergoing extensive installation and laboratory testing by Anthracite Industries.

A further promissory note in the lifting of wartime regulations was sounded by Deputy Petroleum Administrator Ralph K. Davies who announced that most PAW directives covering deliveries of oil well rigging had been cancelled and no new directives would be issued. Also, controls over oil production in California embodied in PAW Directive 19 are rescinded as of October 1.

CENTRAL HEATING AND AIR CONDITIONING FOR APARTMENT HOUSING DEVELOPMENT

Ric-wiL releases economic data on central heating, cooling and other services.

• **A PRACTICAL PLAN.**—A brochure dealing with a proposed suburban apartment housing development originally conceived by Leonard Schultze and associates is being distributed by the Ric-wiL Co. The plans for central heating and air conditioning this project were drawn up by the office of Clyde R. Place, consulting engineers. Ric-wiL's aim is to show how practical economy and cleanliness are advanced by centralization of services among groups of buildings.

Pointing out that the economics of community heating have been fairly well established over a period of years, the booklet goes on to say that one question bound to arise among planners of postwar suburban housing developments for medium income groups is: "Can cooling as well as heating be provided for the tenants, and will the amount of additional rental be small enough to make this extra service attractive?"

• **PHYSICAL LAYOUT.**—The project selected for discussion consists of 36 "bar" shaped and 23 "U" shaped apartment buildings. These 59 residential buildings are made up of 328 apartments and 1.479 rooms. A mechanical building contains the boiler and refrigerating plant, and a system of underground piping from the central plant serves the various buildings. Each apartment would have an automatically controlled, forced air circulating system for both heating and cooling.

• **COST ANALYSIS.**—After determination of the basic design, it was necessary to complete the following studies to make an economic analysis:

(1) Calculation of the amount of heating and cooling required;
(2) A design of the necessary equipment
(3) Estimate cost of installation;
(4) Calculate yearly operating cost for cooling.

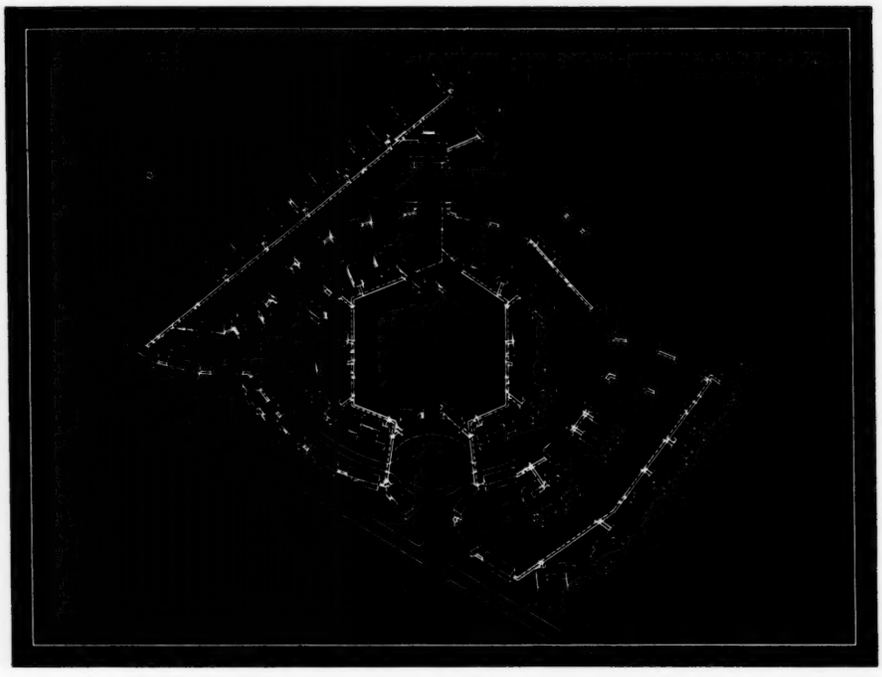
Careful consideration of the design of such a plant indicates that the cost of piping for water distribution will be slightly higher than the cost of high pressure steam piping. This is due entirely to the increased size of piping, since excavation and labor costs will remain about the same. However, the increased cost of water piping will be largely offset by elimination of the need for pressure reducing valve stations, condensate or vacuum pumps, and some complications of boiler plant design. Since chief concern is with the cost of cooling, only those items concerned with cooling are detailed in the following tabulation:

Additional Cost of Cooling

Additional space in boiler plant for refrigeration equipment		$10,000.00
Refrigeration equipment—compressors, coolers, etc.		60,000.00
Apartment air conditioning units:		
Extra coil surface	$10	
Additional automatic control	10	
Larger ducts	10	
Per apartment	$30	
328 apartments at $30 each		10,000.00
Total *extra* cost for addition of cooling		$80,000.00

Yearly Operating Cost of Cooling

Return of investment based on 20-year life of equipment	$ 4,000.00
Average interest at 6% on unreturned investment	2,520.00
Taxes 2%, plus Administration, 4%	4,800.00
Electrical energy at 2c per KWH	6,000.00
Condenser water loss	100.00
Operating labor	3,600.00
Repairs	1,580.00
Total cost of operation per cooling season	$22,000.00
Operating cost per room per cooling season	15.30
Average cost per room per month	1.27



Plan of 328 unit community centrally heated

• **BASIC DESIGN.**—Computations were based on design temperatures for New York City and vicinity. That is, to maintain inside temperature at 80F, dry bulb, and 50% relative humidity when the outside conditions do not exceed 95F, dry bulb, and 75F, wet bulb, in summer; and to maintain 70F inside in winter with an outside temperature of 0F. To save on the cost of refrigeration equipment it was assumed that the apartments having two stories would be cooled on the first story only during the day and on the second story only

during the night. Cooling costs were based on operation at 50% of capacity for 1500 hours per season.

• **PIPING.**—From the central plant a series of underground supply and return water mains would make one or more loops around the property with service connections to each building. These mains would be installed in underground conduit protected against corrosion and insulated so that the water in the pipes would not be materially affected by outside weather conditions.

In underground piping, it is necessary to have expansion joints readily accessible for inspection, or, better still, eliminated by the use of expansion loops. In this project, a reversed return system is used for the flow of water in the two main circuits. That is, the building in each circuit nearest the supply side of the plant has the shortest supply main but the longest return main. Return and supply mains are parallel with the water flowing in the same direction in both. This would result in approximately equal take-off pressures and even water flow to each building.

However, the different distances away from the mains, and different heating and cooling loads for the two types of building would make it necessary to have some means of adjusting the amount of water flowing to each air conditioning unit. Therefore, it would be necessary to provide a test tee in each supply and return connection for manometer and thermometer readings and a plug cock in the supply pipe to regulate the amount of water flowing to each unit. A gate valve is provided in each line to shut off the water to the coils. After the water flow to each unit has been adjusted the plug cock is locked in position and the test tees plugged. From then on, the engineer can vary the temperature of the water in the mains in accordance with outside weather conditions. This would prevent any tenant from getting more than his allotted share of heating or cooling by setting his thermostat at an extreme temperature.

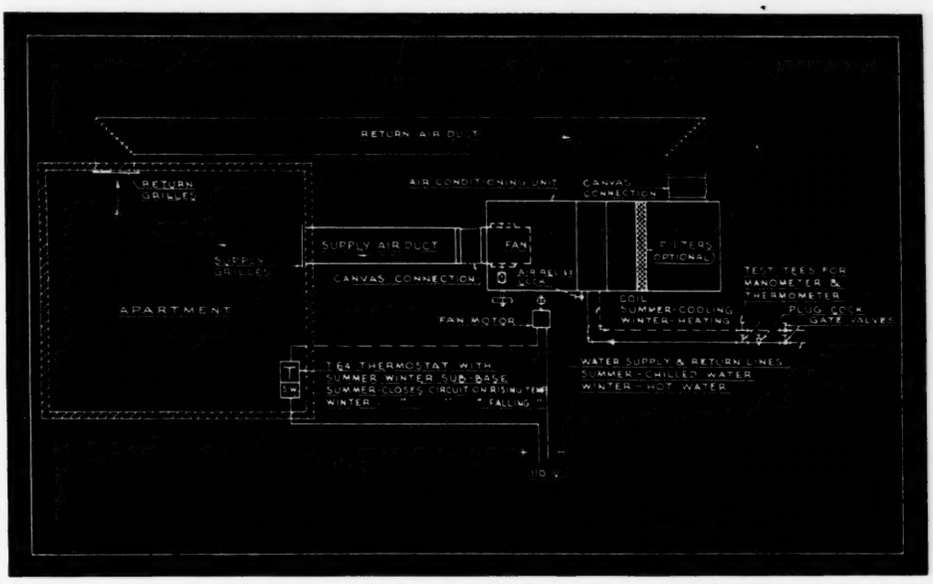
• **APARTMENT UNITS.**—Basic unit for each apartment consists of a conventional type, forced hot air heating unit having a heating coil, motor driven fan, filters, casing and thermostatic control with a system of supply and return ducts between the unit and the rooms.

The room thermostat is arranged to give the tenant three positions of control, "Summer," "Winter," and "Off".

• **OTHER UTILITIES.**—Ric-wiL's study touches the subject of other types of utilities such as gas, water supply, electricity, sewerage, vacuum cleaning, domestic refrigeration and hot water, etc. After a general discussion of other utilities, cost data on centralized domestic hot water as against individual hot water heaters for each apartment is presented.

If gas is available for domestic cooking, says the study, then individual gas fired heaters for each apartment are indicated. In the project under discussion, however, oil is the available fuel, and comparative cost data are drawn up.

With the central system, two hot water boilers with storage tanks are installed in the boiler room and fired with No. 6 fuel oil. Hot water is circulated by means of pumps to all buildings through brass pipes installed in underground conduits laid down in the same trench with the heating and cooling conduits.



Diagrammatic plan of heating and cooling system

Central System

Estimated Installation Cost

Boilers, burners, tanks, pumps, and plant piping	$17,500
Brass supply and boiler piping in plant	9,500
Excavation and backfill (extra above that for heating pipes)	6,000
Brass piping in underground conduit	60,000
Additional area in plant building	2,500
Total installed cost	$95,500

Operating Cost

Yearly return of investment based on 20-year life	$ 4,775
Average yearly interest at 6% on unreturned investment	3,050
Taxes—at 2%	1,910
Electrical energy at 2c per KWH	280
No. 6 fuel oil at 4c per gallon	6,000
Repairs	1,200
Total estimated yearly operating cost	$17,215

Monthly cost per room.....97 cents

Unit System

Estimated Installation Cost

Boilers, burners, oil tanks, storage tanks, circulating pumps, brick stacks and connections to mains (one unit per building)	$59,000
Brass supply and circulating mains in buildings	9,500
Total Estimated Cost	$68,500

Operating Cost

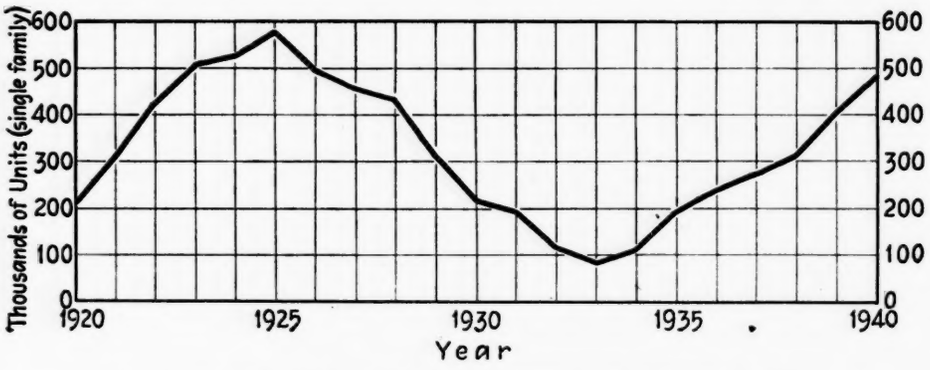
Yearly return of investment based on 20-year life	$ 3,410
Average yearly interest at 6% on unreturned investment (20-year period)	2,200
Taxes at 2%	1,370
Electrical energy for burners and pumps at 2c per KWH	1,620
No. 2 fuel oil at 6c per gallon	9,000
Repairs (59 units)	2,000
Maintenance (one extra man)	2,400
Total Estimated Yearly Operating Cost	$22,000

Monthly Cost per Room.....$1.24

FORUM STUDIES HOUSE MARKET

Survey conducted by Crossley, Inc., for "The Architectural Forum" modifies rosy house-buying outlook.

• **WHAT IT IS.**—In order to put a realistic finger on what actually goes on in the private home market as a postwar activity, a study was conducted for the editors of *The Architectural Forum* by Crossley, Inc. Crossley's experienced interviewers talked with 8,052 men and women heads of families (including a few who are about to be married). They used a long questionnaire, which had been put together after a small intensive study of housing attitudes and then carefully field tested in a pilot study of 1,000 cases. Length of the questionnaire proved to be no drawback, since the majority of questions were to be asked only of those interested in houses and these were also interested in talking about them. The sample represents a national cross section of U. S. families weighted for economic, geographic, and cultural factors. Interviews were obtained during December, 1944, January and February, 1945. This study is concerned with people whose present attitudes qualify them as prospects for buying or building houses for themselves. It does not include anything about houses or apartments built for rent.



Number of single family dwellings constructed over 20 years.

• **WHO'S A PROSPECT?**—While it is fairly hard to find an American family nowadays without some kind of plans for a better postwar home (70% believe it is better to own their own home), there is nothing inevitable about the hoped-for market of one million houses a year over the next decade. In an attempt to find what could be called immediate prospects, it was discovered that only 34% of the population is actually personally interested in building or buying a house some time in the future. Although one-third are interested, it would be quite obviously fallacious to base market estimates for such a major purchase on a mere statement of interest some time in the future. The basic question is: How many of these people are really prospects for houses in the years immediately following the war?

To isolate those most likely to translate their interest into action, "filter" questions were asked to determine who had already taken steps or had definite buying plans for the immediate future. On the basis of answers, each interested person was given an index rating which breaks the prospective house market down into various levels of dependability.

• **BOOM?**—Half of the interested group were either thinking about buying more than five years after the war or were so vague about their plans that they could only be considered daydreamers. One-sixth of those interested intend to buy from three to five years after the war. Regardless of the definiteness of their plans, these people cannot be considered prospects for the period with which builders are immediately concerned. Another tenth of the interested group have plans which, while more immediate, must be considered doubtful on the basis of the filter questions.

There remain two groups which are regarded as the mainstay of the prospective house market. People in one of these groups—6% of the total sample—are called borderline prospects who, though they plan to buy in the first two or three years after the war, see possible reasons for delay. The remaining 1.5% of the total group plan to buy or build before the end of the first year after the war, have taken important steps toward owning, are certain of their plans, and see no reason for delay.

Filtered out in this way, the minimum market for houses over the next year is 1.5% of all U. S. families—unless prices shoot way up or unforseen things happen. If all these sure prospects decide to buy *new* houses, 555,600 homes will be built. This would approach the 1925 peak when 572,000 single family houses were built.

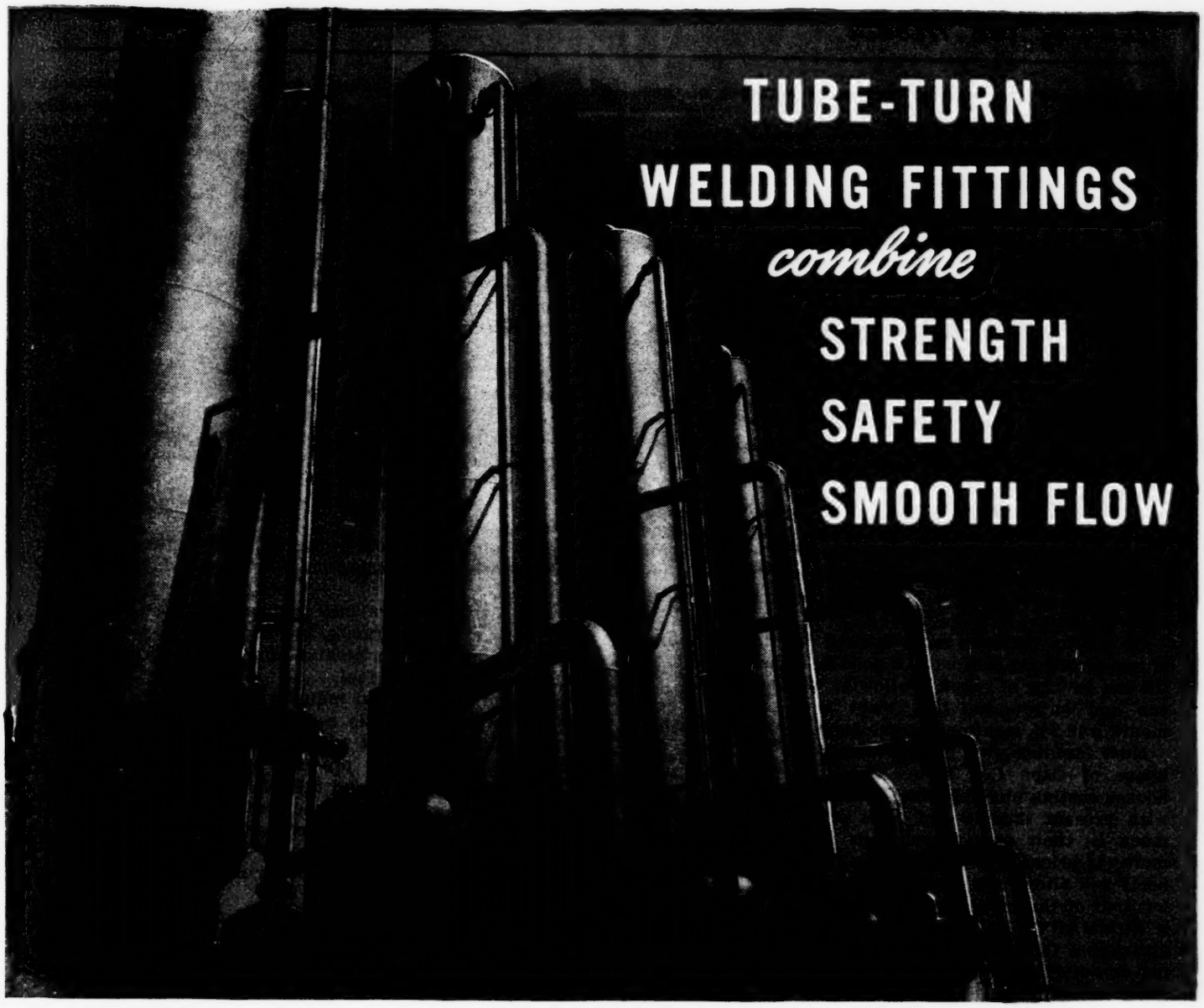
Forum's report goes on to say: "Housebuilding's maximum market—spanning the first two or three years after building gets a good start—can be gauged by adding the 6% of all U. S. families whom the survey classes as Borderline Prospects. In presenting market data, the survey combines this group with those we can safely call Sure Prospects. Together the two groups represent 7.5% of all U. S. families. This means that 2,778,000 U. S. families are Good Prospects for house sales over the next few years. A boom market? Well, maybe . . . Before you start reaching for your slice of it, consider the likelihood that many of these families may not buy new houses. Some 73% say they want to. But past experience shows that ordinarily 60-75% of all prospects settle for older houses.

Grading and analysis of prospects show clearly that A BOOM MARKET IS NOT INEVITABLE. Whether housebuilding reaches record level depends on how many people now making tentative plans can be drawn into the market, and this in turn will be determined by favorable or unfavorable conditions within the industry and the country as a whole.

It is clear that housing prospects will have to be SOLD and sold aggressively if the maximum potential of the housing market is to be realized. Obviously the building industry cannot afford to assume that the market will absorb as many houses as can be built—no matter what they are like or what they cost. As in every other market where a product must be sold, it is essential to know *who* the prospects are, *what* they want, *why* they want it, and *how* they may finally be persuaded to buy—or dissuaded."

• **G. I. BILL.**—Stimulation of interest in house buying by the G. I. Bill of Rights is reflected in returns from servicemen's wives. While one-third of all the people in the sample expressed an interest in buying or building a house some time in the future, about 64% of all servicemen's wives said they hoped to be home owners some day. Some 10.8% of G. I. wives turned out to be good prospects compared with 7.5% in the total sample. Seven out of ten G. I. wives have heard of the Government provisions for loans to veterans, and if they have heard of it, they are much more likely to be good prospects. Of those who are informed about the bill,

(Continued on page 120)



PHOTOGRAPHED in Louisiana, this is a section of the world's largest field stabilization, gasoline recovery and pressure maintenance plant. Such an investment calls for the utmost in engineering for trouble-free performance. Tube-Turn welding fittings were specified.

Among the reasons governing this choice in fittings were the extra strength resulting from Tube Turns' exclusive manufacturing methods, the safety insured by this strength, and the efficient flow made possible by smooth, obstruction-free inner surfaces. The considerable saving in weight over other type fittings is also an important factor in this type of construction.

For complete information on the superiority of Tube Turns' exclusive manufacturing methods and data on successful installations in many industries, write for latest complete Catalog 111.

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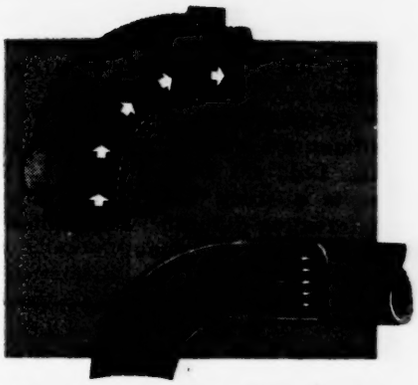
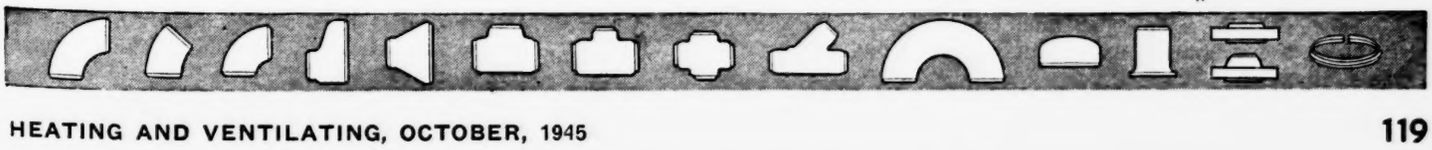
TUBE TURNS (Inc.), Louisville, Kentucky. *Branch Offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, San Francisco, Seattle, Los Angeles.



Compare for Smoothness

See how sharp corners and surface irregularities obstruct flow in cast iron threaded elbow. Compare for smoothness with unobstructed flow in smooth Tube-Turn elbow.

TUBE-TURN TRADE MARK *Welding Fittings and Flanges*



13% are good prospects as compared with 5% of those who are not informed.

• **WHAT KIND OF PEOPLE.**—As compared with the total population sampled, those classified as good prospects show some differences in characteristics—significant and otherwise. Relatively fewer of them are in rural areas; more of them in small cities. The west has a larger proportion of good prospects than the northeast. Good prospects tend to be younger and to have moderate sized families of three to five members. They tend to have lived in their present homes for shorter periods and to be more dissatisfied with them.

Good prospects have higher incomes, but the lower income groups ($2,000 to $4,000) still provide the bulk of the market. That is, while 48% of the total sample have incomes under $2,000, only 28% of good prospects are in this income level. In general, good prospects have more schooling and feel more secure about their jobs and future income.

• **THEY KNOW WHAT THEY WANT.**—More than half of the good prospects have saved money or bought bonds specifically for a house. Nearly three out of every four of the non-farm good prospects intend to buy a new house and half want a house specially designed and built for them.

Of all the features most desired in the new homes of non-farm good prospects, a good heating system heads the list in 35% of cases. Following well-equipped kitchens and bathrooms, 13% want good, liveable basements, and 9% mentioned some form of air conditioning.

Most families want five or six rooms in a one story house of Cape Cod style. Half the prospects want houses costing under $6,000. Estimated costs are in line with present income and most are willing to pay as much as their present rents or more—but not much more. If prices take a big jump, few of the good prospects will altogether give up the idea of buying a house, but half of the immediate market will recede.

• **SUMMARY.**—The results of this survey indicate that although a third of U. S. families are interested in buying or building some time in the future, only 7.5% can fairly be called good prospects for the next two or three years. Of these only 1.5% are sure prospects in the immediate market. On the whole, plans of good prospects are practical and well financed, but they depend upon job security and price ranges where the demand exists.

• **CANADIANS.** — Entitled *The Housing Plans of Canadians*, a booklet prepared by Maclean-Hunter Publishing Co., Ltd., 481 University Ave., Toronto 2, Canada, presents a study similar to *Forum's* survey and shows interesting differences in replies by province and sex as well as income group.

STOKER MAKERS MUSTER FOR PEACE

Coal sizing, smoke prevention, and research keep SMA fires burning.

• **THE NEEDLE.** — In his chairman's report of the anthracite section, Stoker Manufacturers' Association, presented at SMA's 28th annual meeting in Chicago, Milton A. Young gave the constructively critical needle to anthracite coal producers.

Said Mr. Young:

"Our biggest problem is the anthracite coal producers; particularly their attitude toward domestic stokers. They have nothing against stokers, but they do not like to see the so-called rice and buckwheat anthracite replace the prepared sizes. Let us take that one and talk about it.

"During the very same years when the anthracite industry was very busy losing 20 million tons and steadily shrinking, the stoker industry gained ground and grew steadily. The stokers sold in this period saved about 2 million tons for the coal boys. In the same period rice anthracite rose from $1.10 to over $4.00 a ton at the mines.

"The anthracite producers think we stoker people like rice and buckwheat coal because it costs less. This is not so. There is not a single manufacturer of anthracite stokers who has protested against any advance in the price of this fuel nor who believes the price of the fuel, within reason, has anything to do with sales. We like rice and buckwheat coal simply because it is . . . more readily handled mechanically and, therefore, lends itself to as near complete automaticity as can be achieved. It is as simple as that. Actually stoker sizes of coal are a premium fuel because they can be automatically fired.

"The coal producer is yield and size conscious.

"The stoker manufacturer is method or utilization conscious.

"The anthractie coal producer is like a very particular maiden who cries 'Bring me flowers, but bring me only orchids.' . . .

"It is true stokers may compete for the hand-fired, prepared sized anthracite, but so does every other conceivable kind of automatic equipment burning every kind of competitive fuel. . . .

"The anthracite coal industry would like to see some manufacturer stick his neck out with a Buck Rogers, atom-smashing rocket tube to utilize and only utilize certain sizes of their product, but in traveling among the most progressive and reliable stoker manufacturers, I can find no evidence of such intent, and I cannot conceive of any sane manufacturer throwing away hard earned acceptance of an already established product to buck the heating trade, the boiler manufacturers and his own dealers.

"Please pardon the criticism of the anthracite coal producers. . . . Such criticism . . . . here is intended to be constructive, for I assure you we are here to build up and not tear down. After all, the anthracite stoker manufacturers and the anthracite coal producers are bedfellows and we can go forward together only if we understand each other's purpose and policy."

• **SMOKE.**—A second report delivered at the Chicago SMA meeting was that of A. O. Dady, chairman of the engineering and research committee. Mr. Dady told of a meeting of a subcommittee of the Greater Cincinnati Stoker Association with members of the City Smoke Department concerning provisions of the Cincinnati Smoke Ordinance which "are working a hardship on the stoker industry in the city."

This meeting resulted in definite recommendations for revision of certain sections of the ordinance which would make it more practicable and acceptable. Members of the subcommittee have agreed to submit recommendations on these revisions as well as their individual ideas of an overall smoke regulatory ordinance based on the experience of other cities. Mr. Dady's report continues:

"An increasing tendency for smoke abatement departments to promulgate ideas of their own beyond the sphere of their legitimate action is noted. In one case, a design for an automatic air control was detailed and put forth as being acceptable under the ordinance. In another, a formula has been evolved — but without numerical values — covering the design factors for burning heads of underfeed stokers.

"With the ending of the war, there will be increased activity and stricter enforcement of smoke regulations. It is of vital concern to the (stoker manufacturing) industry that . . . a workable liaison (be) maintained. . . ."

Further evidence af activity in the smoke abatement

(Continued on page 122)

did you ever see DIRT before?

THIS is what it looks like, magnified 100 times. Sharp flint-like, often germ-laden.

Unfortunately, your products, machinery, merchandise or even customers and workers find dirt harmful—and without the help of a microscope.

Wherever people, machinery, materials and processes are exposed to air, they are subject to the effects of air-borne dirt—infection, abrasion, contamination and the like.

Separating dirt from air is the job on which Air-Maze has specialized for nearly 20 years. Take advantage of this experience. Send your problems to us, or consult the yellow pages of your telephone directory for your nearest Air-Maze representative. Air-Maze Corporation, Cleveland 5, Ohio. *Representatives in principal cities. In Canada: Williams & Wilson, Ltd., Montreal, Quebec, Toronto, Windsor; Fleck Bros., Ltd., Vancouver, B. C.*

IF IT USES AIR . . . USE
AIR-MAZE
ENGINEERED AIR FILTRATION
• Oil bath type filters and filter-silencers • Cleanable filter panels for air-borne dirt, oil, grease and liquids • Oil-wetted type filters and filter-silencers
• Exhaust spark arresters • Gear case, crankcase and tank vent breathers
• Oil-separators for engine crankcases • Full-flow type cleanable oil filters

field is in the announcement by Frank A. Chambers, secretary of the Smoke Prevention Association of America, that the association will hold a national conference in Columbus, Ohio, October 16-18. The meeting will be addressed by Dr. R. R. Sayers, chief of the U. S. Bureau of Mines, and Dr. H. J. Rose, vice-president of Bituminous Coal Research, Inc.

• **RESEARCH.**—Some progress in smoke control of stoker-fired installations is evidenced in the Bituminous Coal Research progress report of tests on a stoker-fired 100 hp HRT boiler run by Battelle at Ohio State University to determine the effect of over-fire air for smoke elimination on boiler efficiency.

Comparison	Without Jets	With Jets
Burning rate, lb coal per sq ft per hr	16.7	16.7
Air to jets, per cent of total	——	22
Average CO_2, per cent	12.1	11.7
Excess air, per cent	44	51
Average flue gas temp., F	624	586
Average smoke density by recorder, Ringelmann No.	1.8	0.4
Loss in gaseous combustible, per cent	0.0	0.0
Efficiency, per cent	70.1	70.4

The flue gas temperature remained substantially constant during the tests with the jets, but climbed steadily as the result of accumulation of soot during the operation without the jets. The tests show that the fan jets can practically eliminate smoke without loss in efficiency.

Other notes from BCR's progress report are quoted as follows:

"*Residential Stokers:* An accelerated rate of effort was devoted to the construction of the inverted underfeed combustion unit, which has been under test continuously since May. Burning rates of over 50 lb per square foot of grate area were readily obtained in the compact, water-jacketed furnace. The tests included both high and low volatile coals.

"No trouble with coke formation has been encountered thus far. The CO_2 content of the flue gases was 13 percent, which is more than satisfactory.

"Holdfire operation for prolonged periods was obtained at only slightly over one pound of coal an hour, even with strongly coking coals, but changes in design are contemplated to further reduce the holdfire consumption.

"Continuous removal of ashes from the fuel bed and crushing of pieces of slate and fused ash are inherent features of the machine.

"*Residential Group Heating:* The heating of a group of residences from a central, coal-fired plant has been studied intensively to determine the most favorable arrangements. The First Progress Report, which gave estimates for the heating of 40 houses with circulating hot water, showed a questionable competitive position for coal as compared with gas and oil under fuel prices such as exist in Columbus, Ohio.

"A second progress report now in preparation will include an analysis of 80-house and 120-house projects, conceived by a Columbus architect, and heated by steam. Increasing the number of houses reduced the unit costs."

PREFAB UTILITIES PACKAGE

Borg-Warner combines heating, plumbing, refrigerating, lighting in single small homes unit.

• **PREFAB.**—A step in the direction of prefabricated housing promotion has been taken by Borg-Warner Corp. in the introduction of a home utility unit which combines space and water heating, plumbing, refrigeration, kitchen and bathroom lighting and fixtures in a single unit the core of which, without the range and refrigerator, weighs about 1,000 lb and can be rolled through an ordinary doorway.

One side of the unit contains a thermostatically controlled oil or gas furnace with forced circulation of warm air. The core of the unit is so engineered that a workman can get inside for service. The furnace side of the unit also carries the hot water heater, electrical connections, and meters.

On two sides, the central core provides sink, range, mechanical refrigerator (Borg-Warner's Norge), laundry equipment, and kitchen cabinets with work counter space. On the fourth side are all bathroom fixtures and accessories.

• **SPECIAL DESIGN.**—Partitions of the house must be designed to accommodate the unit's divisions, and outside utilities connections are made to a built-in template incorporated in construction of the house. Twelve small home designs have been drawn up to use the package to best advantage, and the low-cost unit will go into production at the Ingersoll Division in Kalamazoo.

BALTIMORE CLEARS THE AIR

Program to reduce smoke over city is under way.

• **VIGOROUS.**—A "vigorous program" to reduce the amount of smoke, soot and ash in the air over Baltimore is under way and "some good results are already apparent," J. H. McKay, city smoke abatement engineer, asserted recently.

Letters have been sent out to the operators of industrial plants, apartment houses, hospitals and others "who have been offenders," advising them that materials and equipment for the abatement of smoke and its solids are rapidly becoming available. The letter also notes that the railroads are "going ahead" with the installation of smoke-consuming devices in some instances and substituting Diesel locomotives for coal-burning engines in others.

The letter has had many responses, Mr. McKay said. A number have been inquiries as to the sources of equipment and requests for assistance in its selection. Such assistance, Mr. McKay stated, is being given gladly.

• **WORTH A MILLION.**—A large public service company with a plant in South Baltimore, the engineer stated, is preparing plans to install a fly-ash collection device at a cost of $1,000,000.

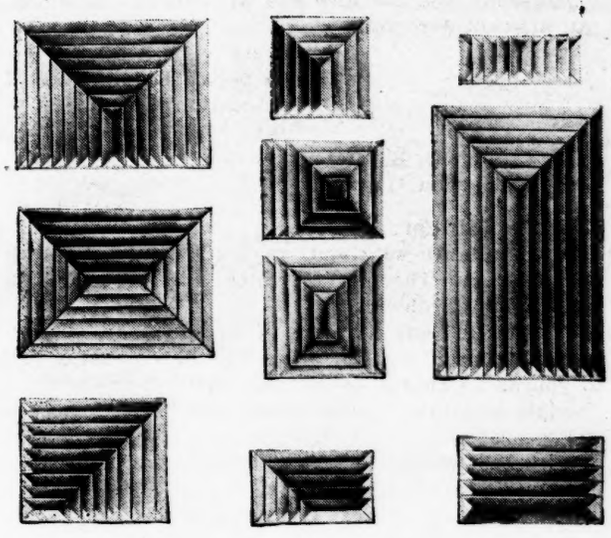
The Johns Hopkins University is prepared to install an ash-collection device that will cost approximately $14,000.

The contract has been let by the university but its officials have been informed that the earliest shipping date on one essential piece of the equipment—an induction fan—will be 22 weeks hence.

Mr. McKay said the university would have moved to eliminate its ash nuisance earlier except for the fact that the Federal Government was using the laboratory in a night and day operation. It would have been necessary to shut down the laboratory to install the equipment.

• **INTEREST.**—Several hospitals and industries have indicated their interest in ash-collection devices to prevent the distribution of ash and soot into the air through chimneys and smoke stacks. Many of the smaller establishments, however, will shift to oil burning equipment instead of acquiring the expensive collection machinery, Mr. McKay predicted.

HOW TYPE R FITS ODD-SHAPED ROOMS



HOW GOOD IS AIR CONDITIONING WITHOUT *Diffusion Pattern Control?*

WITH AGITAIR TYPE R DIFFUSERS you can now achieve perfect air distribution and diffusion in any shape of room—from practically any location in the room—without drafts, hot spots, cold spots, or blank corners. That's "diffusion pattern control."

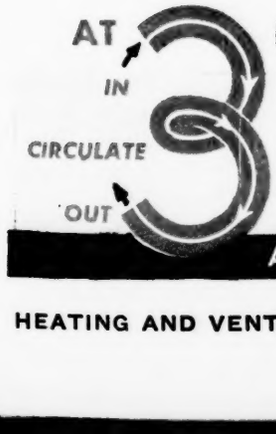
Agitair Type R's diffuse the incoming air toward one, two, three, or four sides of the room as required. The volume of air in each direction is in exact proportion to the area served. 64 venturi-type, noiseless orifices per square foot rapidly dissipate temperature differential and initial velocity.

Why worry about the ceiling center?

It's easy to provide perfect diffusion from any point in the room simply by selecting off-center, side-wall, or even baseboard patterns of the Type R.

There's an Agitair for every room and every condition

Assembled from standard parts, even the most complicated Type R shapes are economical. Ideal for low head-room. Write today for complete facts.



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THERMOSTAT SOLVES JUNGLE PROBLEM

Constant temperature control sent to technician in Burma hospital to keep laboratory cultures accurately warm.

• **S-O-S.**—The adaptability and multiple uses of automatic temperature control are well illustrated by the following exchange of correspondence between a harassed staff sergeant along the Ledo Road and Minneapolis-Honeywell:

Minneapolis-Honeywell Regulator Co.
Minneapolis, Minn. 28th, May, 1945
S-O-S from Jungles of Burma.

Dear Sir:

I am stationed in a hospital along the Ledo Road. We have a situation here I'm sure you can remedy. We have a box (home made) in which cultures are kept. (Laboratory work). The heat is supplied with electric light bulbs (2). We are using a crude makeshift regulator made from strips of zinc, a clock spring, with contact springs from a distributor off a wrecked jeep. This works in a fashion. *But*, it keeps the lights flickering, causing many burned out bulbs, radio noise (bulbs are darned hard to get), and it's not reliable.

Having used your equipment prior to my enlistment in the Army, I feel sure you have what we need. What I have in mind is a thermostat (room type) with mercury contacts. This type was used on oil and gas heaters. The range we want is 30 degrees Centigrade (88F). Also would it be possible for you to send the above item to me—*Registered Air Mail*—and forward the bill. I know this is asking a lot, but it sure would help us here as we need it badly.

Thanking you for any and all trouble; in hopes you can help us, I remain

Sincerely,
(signed) S/Sgt. Ralph G. Killifer
73rd Evacuation Hospital

S/Sgt. Ralph G. Killifer
73rd Evacuation Hospital

Dear Sgt. Killifer:

In compliance with your request, we are shipping you one TA42A10 Thermostat which will probably answer your control problem.

This device has a range of 60F to 100F with a differential at mid-scale of 2F to 3F. This is being shipped to you at no charge as we are very happy to be of any possible assistance in the work which you are doing so well.

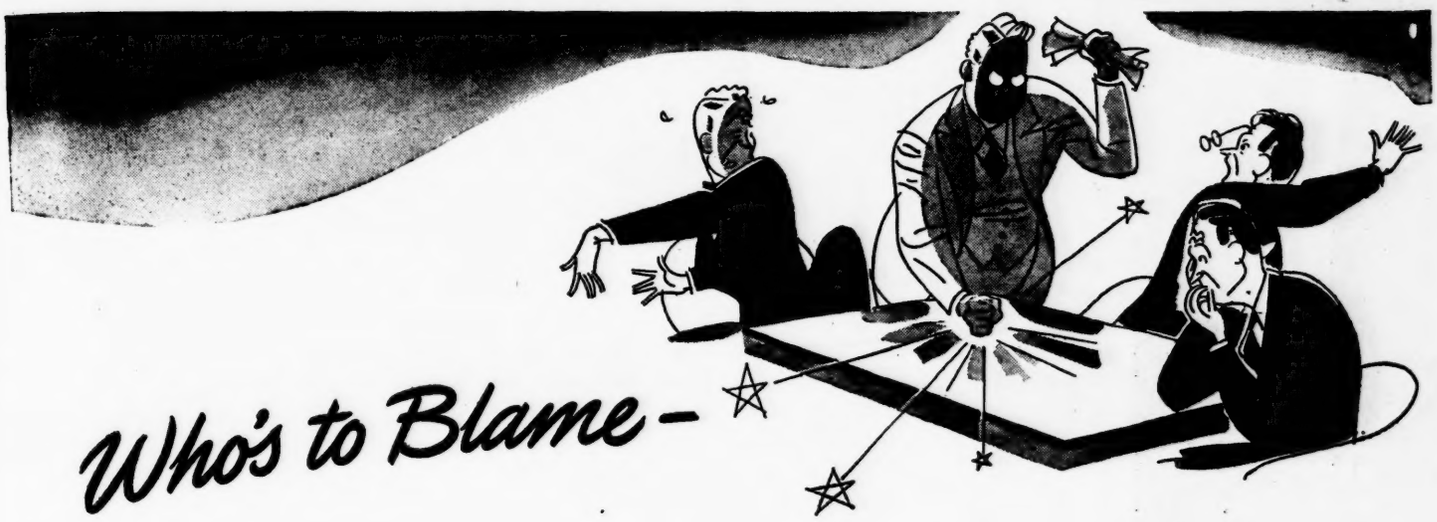
With best wishes for a speedy and safe return to your home.

Very truly yours,
J. A. Young
(Catalog Department)

Dear Mr. Young:

The control arrived today, and like all recruits in the Army was put to work at once. Everything was in fine shape upon arrival. I must say it does as much as we asked for and more, too. The difference between on and off is .8 of a degree. Even now "Little-Jo" is busy. On three min. and off six. You could compute the time it would come on one hour later and not miss it by one min. . . . We feel assured that anything placed under the watchful eye of "Little-Jo" will never go wrong. I wish to thank you and those responsible for the receipt of such a fine Stat.

Gratefully yours,
Ralph G. Killifer.



Who's to Blame—

if Air-Filter Maintenance Costs get "OUT OF LINE?"

When the cost of getting clean air gets "out of line"—somebody has slipped. Perhaps it was due to the original specification, perhaps the maintenance man's budget couldn't stand the load or perhaps the front office overlooked the balance between original cost and upkeep which can be maintained when the right equipment and Dust-Stop* Air Filters are used.

The man who installs the equipment?

The Heating and Ventilating Engineer won't be on the spot if he has specified adequate equipment and recommended Dust-Stops. Many engineers prefer Dust-Stops and the complete, ready-to-assemble steel cell frames, because of their ready adaptability to virtually any system, regardless of the C.F.M. requirements.

The proved efficiency of the Dust-Stop, flexibility of installation, easy access to filters, and the low cost of this part of the system are but a few of the other reasons for the widespread preference for these efficient replacement-type air filters.

The man who maintains it?

The maintenance man will be in the clear if Dust-Stops are in the system. Dust-Stops can be obtained quickly from local suppliers and replacement of Dust-Stops in the frame cells is accomplished with a minimum of man power and time.

***OR* the management men who bought the equipment?**

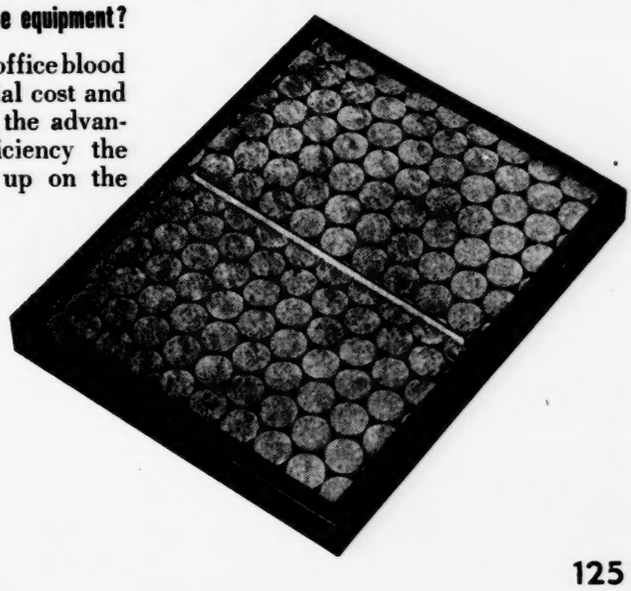
Dust-Stops help keep front-office blood pressure down. Where initial cost and upkeep are balanced with the advantages of air filtering efficiency the use of Dust-Stops shows up on the profit side of the ledger.

The Dust-Stop Air Filter is constructed of packs of glass fibers (Fiberglas*) coated with an adhesive, faced with metal grilles and bound on the edges with a fiberboard frame.

The Fiberglas fibers, packed to proper density, form an exceptionally effective medium for air filtration. Being glass, they are inorganic, chemically stable, resistant to heat, corrosive vapors and most acids. And, being glass, they do not absorb the nonodorous, nonevaporating adhesive with which they are coated. Each impinged particle of dust is quickly soaked, acting as a wick to carry adhesive to other particles. Thus, the adhesive remains effective until the filter is so heavily loaded with dust that resistance to air flow calls for replacement.

For complete information and typical Dust-Stop installation details, see Sweet's Files or write: *Owens-Corning Fiberglas Corporation, 1912 Nicholas Building, Toledo 1, Ohio.*

In Canada, Fiberglas Canada Ltd., Oshawa, Ont.



DUSTOP AIR FILTERS

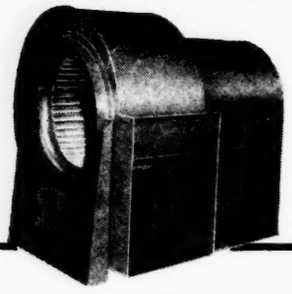
PT. M. REG. U.S. PAT. OFF.

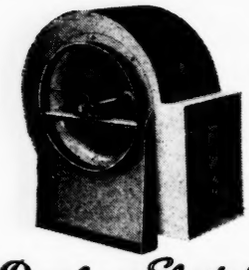
—a FIBERGLAS product

MAKE YOUR VENTILATING JOBS Peerless Electric

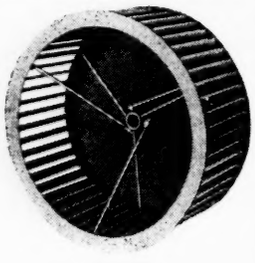
and get the benefits of 50 years' experience in building quality motors and electrical apparatus

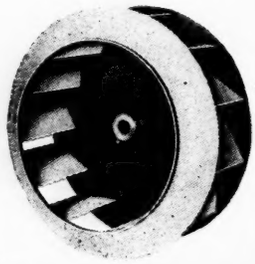
- 26 BELT DRIVE SIZES
- 12 DIRECT DRIVE SIZES





Peerless Electric
VENTILATING BLOWERS
SIZES 12" to 48"
Shown here in Arrangement 3





Peerless Electric
BLOWER WHEELS
Forward curve and backward curve blower wheels full welded construction carefully balanced for smooth, quiet rotation.

Peerless Electric
VENTILATING SETS
Belt drive units are powered with ½ to 7½ h.p. motors; direct drive units ½ to 2 h.p. motors. All units supplied with or without weatherproof hood covers for drive mechanism.

NO matter what your needs—for small jobs or large jobs—it will pay you to make Peerless your headquarters for ventilating equipment. More than 50 years of experience have given Peerless Electric the "know-how" that enters into the design and manufacture of Peerless Electric fans, blowers and ventilating equipment, entirely in our own modern plant. Peerless Electric is small enough to study your needs and special applications intimately—large enough to supply your complete requirements.

Write us for details on any standard Peerless Electric ventilating equipment, or tell us your special problems.

THE Peerless ELECTRIC COMPANY
WARREN, OHIO
Established 1893

ABSTRACTS AND REVIEWS

Books of other publishers reviewed in these columns may be purchased at list price through HEATING AND VENTILATING, *Book Department. Please enclose remittance with order. Other items, such as articles or pamphlets reviewed, should be obtained from original publishers whose street addresses are shown.*

WELDING HANDBOOK

The newest welding methods and techniques, many of which had a dominant part in turning out wartime goods and armament, are described in the 8th edition of Procedure Handbook of Arc Welding Design and Practice.

It contains standard data on speeds and costs, metal characteristics, stress relieving and preheating.

The material in the book is divided into 8 sections as follows: Welding methods and equipment; technique of welding; procedures, speeds and costs; weld metal and methods of testing; weldability of metals; welded steel construction; design of arc welded structures; typical applications of arc welding in manufacturing, construction and maintenance.

Procedure Handbook of Arc Welding Design and Practice. Limp fabric cover, 5¾ x 8½ in., 1,282 pages, 1,647 illustrations. Published by The Lincoln Electric Co., Cleveland, Ohio. Price, $1.50.

CUTTING OF METALS

A total of 4,124 annotated references are included in the Bibliography on the Cutting of Metals prepared by Prof. O. W. Boston of the University of Michigan.

The material is arranged alphabetically by authors and chronologically by years from 1864 to 1943. It combines parts 1 and 2 published in 1931 and 1935 respectively and besides the material that had already been published, has 3,500 additional listings. The bibliography lists the most important articles on metal cutting, grinding, shaping, treatment of cutting tools, turning, milling, drilling, planing, broaching and reaming.

Bibliography on the Cutting of Metals by O. W. Boston. Flexible binding 5½ x 8½ in., 561 pages. Published by the American Society of Mechanical Engineers, New York, N. Y. Price, $6.50.

IN BRIEF

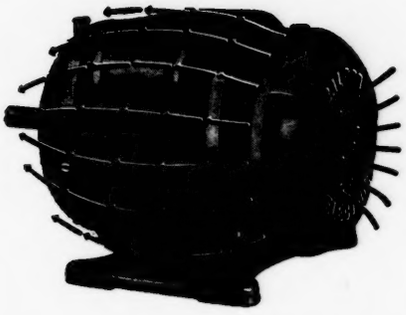
AIR CONDITIONING SHIPMENTS.—There were 153,026 complete units of air conditioning and commercial refrigeration equipment valued at $52,594,000 shipped during 1944, according to the Bureau of the Census, Industry Division report on "Shipments of Air Conditioning and Commercial Refrigeration Equipment, 1944." Figures are broken down as to function of equipment and size of units. As long as the supply lasts, free copies may be obtained from the Department of Commerce, Bureau of the Census, Washington 25, D. C.

CAST IRON.—Extensive data on the corrosion rates of cast iron exposed to the action of substances commonly handled by chemical struc ures feature a pamphlet entitled "Cast Iron in the Chemical and Process Industries," recently published by the Gray Iron Founders' Society, national association of manufacturers of engineering ray irons. It is the work of F. L. LaQue, head of the corrosion engineering section of the International Nickel Co., Inc. Pamphlet is available at $1 per copy from the Society's Cleveland and Washington offices.

MORE *Engineering* DATA on

BALDOR GLASS INSULATED MOTORS

The better the insulation, the better the motor



Above: BALDOR STREAMCOOLED MOTOR; totally enclosed. Arrows indicate air travel over ENTIRE EXTERIOR of motor.

BALDOR, the Better Motor, is made even better by the use of GLASS INSULATION because—

Glass insulation withstands HIGHER TEMPERATURES—as high as 250° C. as compared with 95° C. critical limit for cellulose insulation. Result, less chance for break-down.

Glass insulation makes possible MORE COMPACT, LIGHTER WEIGHT motors. (For example: 10 H. P. motors in standard 7½ H.P. frames . . . and with 135 lbs. LESS WEIGHT.)

Glass insulation is non-hygroscopic—the dielectric strength remains almost as high in humid or damp surroundings as in a dry atmosphere.

Being inorganic, glass insulation does not rot nor deteriorate even when constantly exposed to dampness.

May we tell you more about these BALDOR Better Motors?

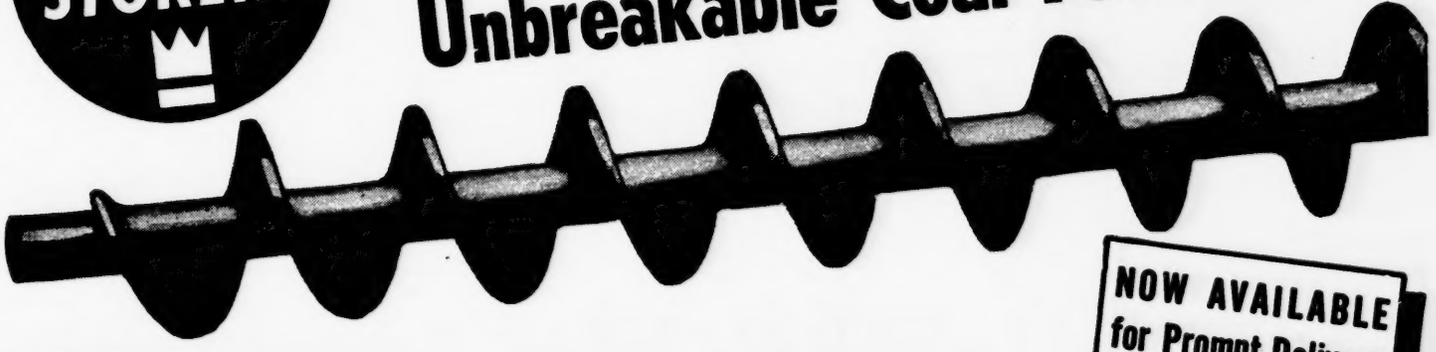
BALDOR ELECTRIC COMPANY

General Offices: ST. LOUIS 10, MO. • *District Offices in Principal Cities*

PLAN YOUR POST-WAR MOTOR REQUIREMENTS ***Now.*** Get the Latest BALDOR Bulletins

For STOKERS

The CROWN Unbreakable Coal Feed Screw



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WELDED All-Steel Worm—All Sizes—All Pitches

★Crown's complete line of all-steel Coal Feed Screws meets every replacement and production requirement. Produced for both domestic and industrial stokers. Crown Screws are available with right or left hand screw, in all sizes and pitches, tapered or straight, and in combinations of pitches. Uniformly smooth surfaces insure that coal will flow freely and easily through the flights. Because it is all-steel with continuous weld, the Crown Coal Feed Screw guarantees long, continuous operation with full customer satisfaction. Crown is in a position to make prompt delivery on all sizes.

In ordering give complete specifications on size and design.

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Write for Quotation on
ADSCO-BANNON
TILE CONDUIT
with Fiberglas Insulation

Made of vitrified clay tile, insulated with "Fiberglas" insulation, it is a combination that can't be topped for permanency or efficiency. Write for quotation giving length of line, size of one or more pipes, steam pressure and temperature — or for further information ask for Bulletin No. 35-67 HV.

AMERICAN DISTRICT STEAM COMPANY NORTH TONAWANDA N. Y.
Makers of "UP-TO-DATE" Steam Line Equipment For Over 65 Years

MINIMIZING SLIME
And Scale Formation on
Evaporative Condenser Coils

By controlling the formation of slime and scale on the exterior surfaces of evaporative condenser coils, you can save many valuable hours of maintenance later on. This is particularly true if you are located in a hard water area.

Put preventive maintenance of these units on an efficient, low-cost basis by using this corrective treatment. Introduce Oakite Airefiner No. 52 into re-circulating water supply in sump. It will inhibit slime growth and retard or prevent lime scale formation on coils. For further details, directions on how to remove slime and scale already formed and the cleaning of coil interior surfaces . . . send for free 4-page special Service Report. No obligation, of course.

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Technical Service Representatives in All Principal Cities of the United States and Canada

OAKITE Buy Bonds for Victory CLEANING

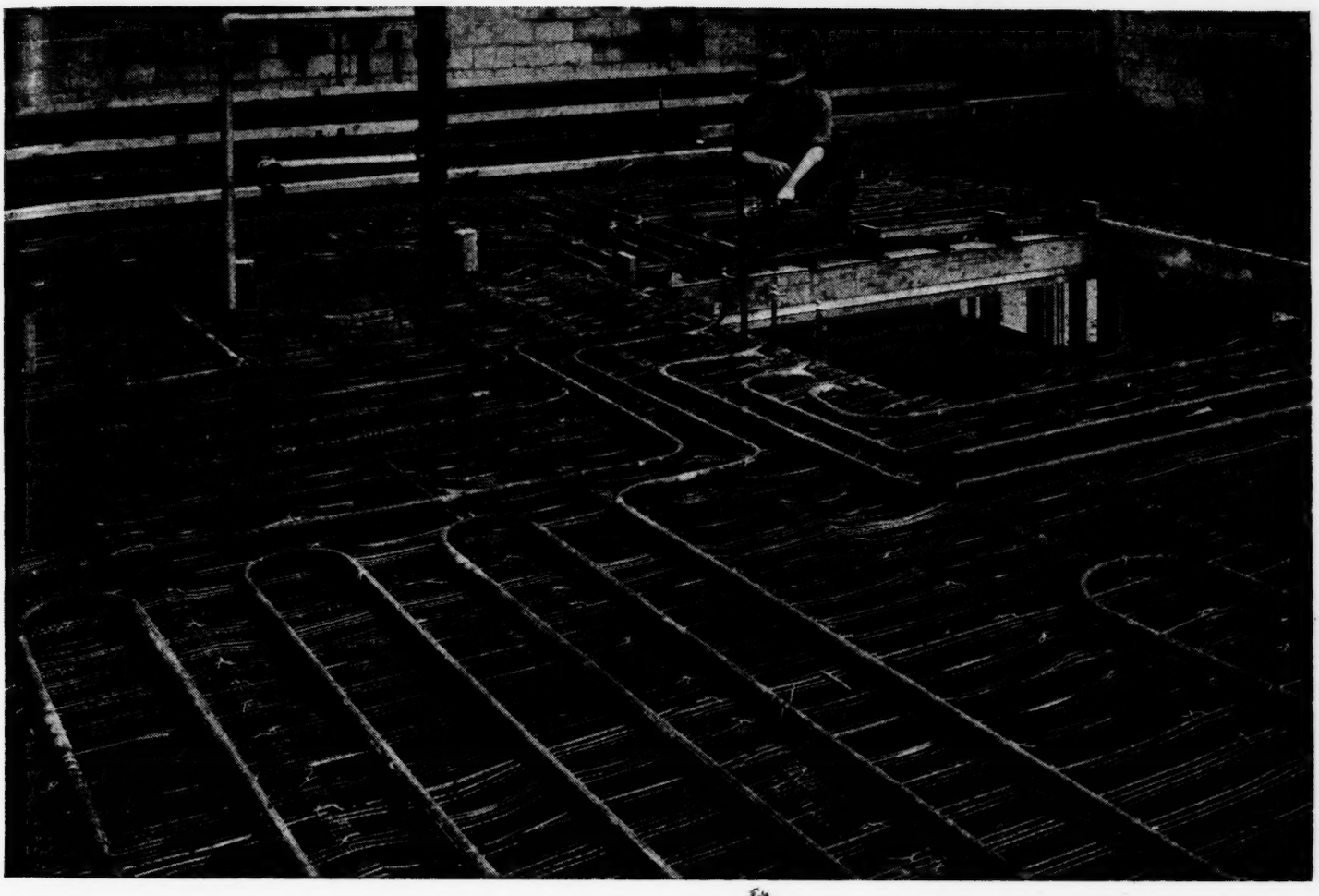
SELECTION OF A CULTURE MEDIUM FOR BACTERIAL AIR SAMPLING.—A study by Schneiter, Dunn, and Caminita of the Industrial Hygiene Research Laboratory, National Institute of Health, points out three requirements for a satisfactory culture medium for air sampling as follows: (1) It should encourage growth of fastidious organisms from the respiratory tract; (2) it should inhibit non-significant organisms; (3) it should have a standard composition. Of 12 media tested, proteose extract agar was found to be satisfactory for growth of staphylococci and sporulates, and superior to other tested media for the growth of streptococci. A medium with an agar concentration of 1.8% was stable enough for impingement air sampling. This study is reported in *Public Health Reports* for July 13, 1945.

AMMONIA—The rapid growth of new chemicals and the widening industrial use of the common ones, especially during the war, has led the Division of Labor Standards in the U. S. Department of Labor to inaugurate a series of bulletins on controlling chemical hazards in cooperation with the Manufacturing Chemists Association of the United States. The first bulletin is "Ammonia." Others shortly to be issued cover chlorine, sulfuric and nitric acids, formaldehyde, and the anilines. There will be over a hundred such bulletins in the series. Each bulletin describes the hazards of the chemical, its characteristics, safety precautions for installation, handling and storage, protective clothing, permissible and hazardous concentrations, and first-aid treatment. Each bulletin is checked for technical accuracy and practical safeguards with firms manufacturing the chemical through the Manufacturing Chemists Association. A supply of up to 25 copies will be distributed without charge by the division, Washington 25, D. C.

DATA ON HEATING BOILERS—"Net Load Recommendations for Heating Boilers" is published semi-annually by the Heating, Piping and Air Conditioning Contractors National Association, 1250 6th Ave., New York, N. Y. The December issue has just been released and the net load recommendations for cast iron boilers have been revised. Instead of being calculated for coal having a value of 11,000 and 12,000 Btu per lb, a figure of 13,000 is used. The 50-page, paper bound booklet is in two parts. The first section is on cast iron boilers and the second part on steel boilers. Information is valuable to the heating engineer and contractor.

FLOW OF LIQUIDS—As the result of a series of experiments conducted by F. W. Greve, Professor of Hydraulic Engineering, Purdue University, a research paper has been published on Flow of Liquids Through Vertical Circular Orifices and Triangular Weirs. The report contains 72 tables on the flow of various liquids through various size orifices, at specific temperatures. For various heads, the tables give the discharge coefficient, Reynolds number and Weber number.—For copies write to The Engineering Experiment Station, Purdue University, Lafayette, Ind.

I-B-R TESTING AND RATING CODE—The third edition of the I-B-R Testing and Rating Code for Low Pressure Heating Boilers has just been published by the institute. In this edition there are some amendments to the original code released in 1939 and in 1940. The new edition presents data for determining the rating of all cast iron low pressure heating boilers, regardless of size. The code is divided into four parts—rating of boilers, testing of hand fired boilers, testing of oil fired boilers, and the procedure for obtaining I-B-R ratings. Price, $1 a copy. Institute of Boiler and Radiator Manufacturers, 60 East 42nd St., New York, N. Y. Code consists of 73 pages and illustrations.



HOW TO SAVE TIME ON *Radiant Heating Jobs*

Know how to save time, and money as well, when making radiant-heating installations? The answer can be summed up in three words—Choose Ammonoduct Pipe.

Ammonoduct is unusually strong and ductile because it is made from a special low-carbon open-hearth steel. In fact, Ammonoduct is so ductile that it can be bent cold with ease, without danger of fracture of the metal wall. And with Ammonoduct, cold bends can be made at the job just as readily as in your shop—annealing is eliminated entirely.

Here's something else you'll like about Ammonoduct—it's an easy pipe to weld. Even welders who have had little previous experience can make welds which are tight and sound, and free from pinhole leaks.

Ammonoduct has other advantages, too—it readily resists the corrosion encountered in radiant heating, and its coefficient of expansion approximates that of the concrete or plaster used in floors and ceilings. Thus, with Ammonoduct, you can be sure of long, trouble-free service.

Ammonoduct is made by the continuous-weld process, and is regularly furnished in uniform 21-foot lengths, plus or minus one inch. Even with its many advantages, Ammonoduct costs no more than regular steel pipe. Make a habit of specifying Ammonoduct each time a radiant-heating job comes along. Your Bethlehem distributor can supply all your needs.

AMMONODUCT ★ BETHLEHEM STEEL ★

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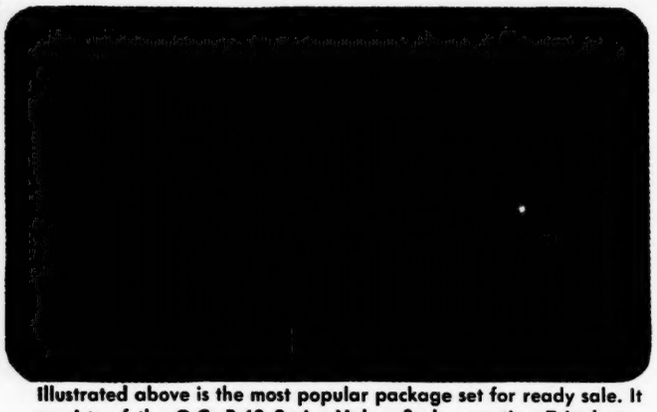
Gas Controls -buy the package

Convenient way to buy, stock and sell General Controls Sets



Illustrated above is the most popular package set for ready sale. It consists of the G.C. B-60 Series Valve, flush mounting Trimtherm, Pilot Burner Generator and 30 feet of wire. This is known as General Controls B-60 all gas system (no outside current required) for manufactured, mixed or natural gas. 50°-90° setting range. A fast selling item. Ask for sales plan.

OTHER G.C. PACKAGE SETS

PLAIN THERMOSTAT SET T-85
Comes with plain Thermostat without Thermometer.

TIMER SET T-95
Consists of B-60 Hand Wound Timer, Thermostat, Pilot Burner Generator and 30 ft. of wire.

RELAY PACKAGE
Type T-100 includes T-70 Thermostat, RS-100 Relay and 30 ft. of 2-wire cable.

GAS HEATING SET *(for line voltage application)*
Type T-30 includes K-3B 2-wire gas valve, T-70 2-wire Metrotherm, transformer and 30 ft. of wire.

Request Catalog 52B and new Service and Instruction Manual of gas controls No. SI-100.

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FACTORY BRANCHES: Philadelphia • Atlanta • Boston • Chicago • Dallas Kansas City • New York • Denver • Detroit • Cleveland • Pittsburgh Houston • Seattle • San Francisco • **Distributors in Principal Cities**

Getting Personal

J. Robert Hughes *(Testing for Pollen Arrestance,* page 83) is a native of Ohio and received his Bachelor of Science degree in 1939. At that time he joined the research department of the Owens-Corning Fiberglas Corp., Toledo, Ohio, and was subsequently assigned to

J. R. Hughes

air filtration research with particular emphasis being placed on the removal of air-borne pollen. Upon completion of this assignment he was appointed chief chemist in the Works Laboratory of the corporation. This laboratory serves as a buffer department between research, sales and manufacturing on matters of raw materials, process and product controls.

. . . Since the Last Issue

Dr. F. E. Giesecke, after 59 years of service in the field of education, has resigned from the staff of A. & M. College of Texas, from which he graduated in 1886. Forty-four of these years were spent at Texas A. & M., and 15 at University of Texas.

F. E. Giesecke

Dr. Giesecke, a past president of the ASHVE, has done notable work in heating and ventilating, particularly in the fields of hot water heating, panel heating, fluid flow, and heat transmission, and is the author of articles, books, bulletins and papers on these subjects almost too numerous to list.

Dr. and Mrs. Giesecke will make their home at the Giesecke homestead in New Braunfels, Tex. He will continue to do consulting work.

Chrysler Corp., Airtemp Division, announced there will be no immediate appointment of a new vice-president in charge of sales to take the place of **P. B. Zimmerman,** who left the Airtemp organization during August to take a principal part in an appliance business of his own. Mr. Zimmerman joins the **Monitor Equipment Corp.,** as executive vice-president and also is vice-president of the management company, **T. K. Quinn, Inc.,** both of New York City. He will continue as president of the Indoor Climate Institute.

The Lincoln Electric Co., manufacturers of arc welding equipment, announces the opening of a direct factory branch sales office, 4427 Manchester Ave., St. Louis, under the direction of **B. J. Brugge** as welding engineer and district manager of sales and service.

As part of the plan to enlarge its sales organization, the **United States Gauge Co.** announces the promotion of **W. S. O'Connor** to national field sales manager to assist L. L. Corcoran, sales manager. **H. M. Bear** will succeed Mr. O'Connor as district manager of sales territory covered by the New York office.

Sigfried A. Olson, Jr. has been named industrial manager at Stockholm, Sweden, for the **Brown Instrument Co.**, Philadelphia division of Minneapolis-Honeywell Regulator Co. Olson has been New York sales engineer for the Brown company for the past nine years.

Guy J. Henry, president and chairman of the board of **Henry Valve Company**, Chicago, has announced personnel changes and new plans for the company as follows: **Charles V. Gary**, recently released to inactive duty in the Naval Reserve after three years service, becomes executive vice-president and general manager. Mr. Gary was sales manager of the company prior to the war. **Richard S. Dawson** becomes vice-president in charge of sales. Mr. Dawson was formerly sales manager of the Alco Valve Company. He has been in the industry since

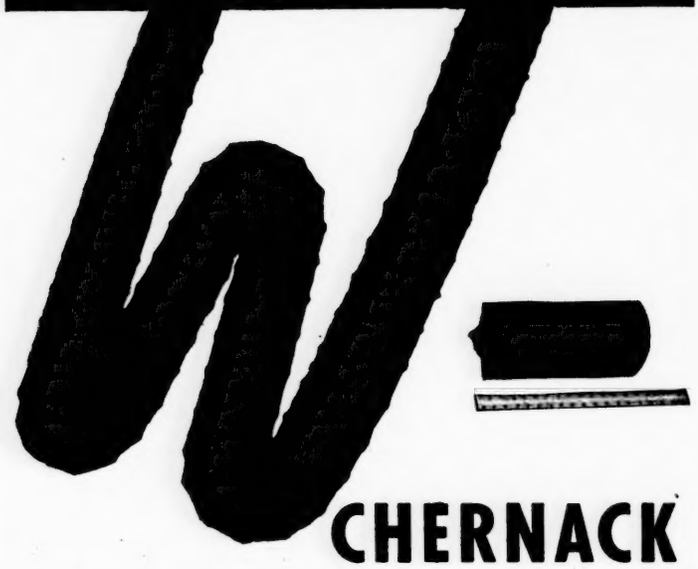
R. S. Dawson *C. V. Gary*

1926 and has been closely identified with educational activities of R.S.E.S., A.S.R.E., and other industry associations. He will be assisted by George W. Wilson who has been manager of jobber sales. **Douglas K. McIlvaine** will be works manager, including administration of the engineering department. Mr. McIlvaine formerly held an executive position with a large electric utility company. During the war he was engaged in electrical engineering and manufacturing in the electronic and control field. **Evan Jones** will be electrical engineer. Mr. Henry commented that addition of the prominent and experienced executive personnel has been made necessary by the continued growth of the Company, and to expand its present line of flow control devices.

The American Rolling Mill Co. has made Middletown, Ohio, a basing point for the various grades and sizes of stainless steel sheets and plates made at the Middletown plant, W. W. Sebald, vice-president and assistant general manager, announced today. The new basing point becomes effective at once.

Sarcotherm Controls, Inc., have opened a new office at 280 Madison Avenue, New York 16, N. Y., under the management of **Louis Barfus, M. E.**, vice-president of the company. Mr. Barfus has been associated with the Sarco Company, Inc., for over 28 years. **T. N. Adlam** will act as Technical Director of Sarcotherm Controls, in addition to his work as Chief Engineer of the Sarco Company.

WHERE CAN YOU USE THIS UNIQUE NEW MATERIAL ?



CHERNACK RETRACTABLE DUCT

What it is

A specialized tubing designed to meet the many industrial requirements for a readily portable duct connection for cold or heated air. Light in weight, yet strong and durable. Flexible to a high degree, which permits its use around sharp corners and over obstructions. Stowable into a small space when not in use. When made of light weight fabric, a fifteen foot length can be stowed in a one foot container. When made of heavier fabrics this ratio is somewhat reduced.

Where it has been used

Typical applications on which this type of tubing has been used successfully include airplane engine preheaters, conducting fresh air into ship holds, ventilating tanks, cars and other enclosed spaces, and portable heaters used in temporary buildings, tents and like enclosures.

Why it may prove valuable to you!

Many variations in construction are possible, depending upon the application. The number of spirals can be increased or decreased from standard, which is four per foot length. Many types of flexible material can be used, ranging from light weight cotton or synthetic fabrics to heavy canvas duct. Fabrics may be impregnated where desirable.

Specifications

Standard Inside Diameters: 4 in., 6 in., 8 in., 10 in., and 12 in. Other diameters made to specification.

Temperature of heated air up to 300° F.

Lengths: 2 feet to 50 feet.

Ratio of retractability: 15 to 1 for standard weight material. End terminations to suit requirements.

For further information write direct to us outlining the applications in which you are interested. We will be glad to submit our recommendations.

THE WIREMOLD COMPANY

Industrial Textile Division

Hartford 10, Connecticut

Trowbridge A. Warner has been appointed sales manager of **Hendrick Mfg. Co.** of Carbondale, Pa., effective October 1, the company has announced. Mr. Warner was formerly sales manager of the Register and Grille Mfg. Co., Brooklyn, N. Y., and before that held a similar post with Tuttle & Bailey Mfg. Co. Mr. Warner has been connected with the heating, ventilating and air conditioning industry for nearly thirty-five years. Hendrick manufactures a complete line of perforated metals, architectural grilles, perforated metal screens, Mitco Open Steel Flooring, Mitco Armorgrids and Mitco Shur Site Treads.

T. A. Warner

Bela Deutch, who has been associated for the past 19 years with Alco Valve Co., recently resigned his position as vice-president in charge of production and factory management to become the head of **Standard Machine & Manufacturing Co.**, located at 8213 Gravois Ave., St. Louis, Mo. Standard will manufacture various refrigeration accessories.

Russell A. Baker has been appointed manager of the Syracuse branch office of the **Minneapolis-Honeywell Regulator Co.** He succeeds Joseph W. Stevens. Mr. Baker, who joined Honeywell in March 1935, is a graduate of the University of Minnesota where he received his degree in architectural engineering.

Redmond Co., Inc., manufacturers of small motors, is placing heavy emphasis on its newly expanded "Customer Engineering Service." Through closely coordinated sales and engineering activities, the extensive engineering facilities of the company are being made available on a broad scale to manufacturers using Redmond Micromotors.

Harry G. Howell, one of the nation's foremost forging specialists and an authority on factory management, is the new vice-president of **Tube Turns, Inc.**, Louisville, Ky., in charge of production. A native Kentuckian, he returns to the Bluegrass after four years as head of Oldsmobile's plant and a total of twenty-two years' association with General Motors. Born in Kilgore, Ky., he attended Purdue and began his career with GM's Buick Division.

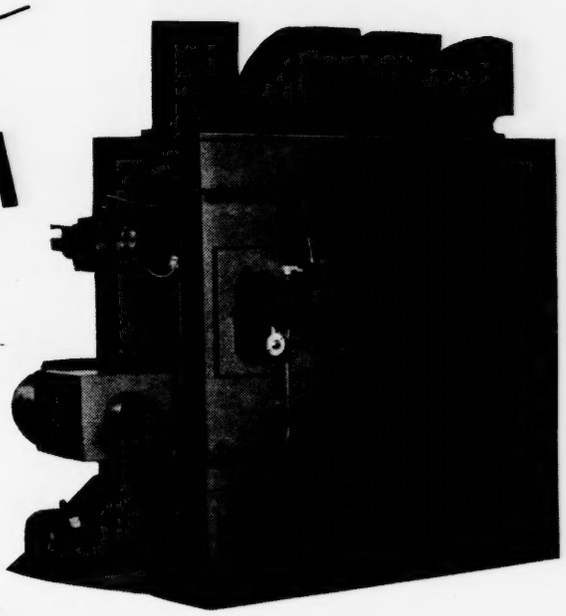
H. G. Howell

On October 1, **Allen D. Brandt, Sc.D.**, Senior Sanitary Engineer, U. S. Public Health Service, commenced his duties at the **ASHVE Research Laboratory** to conduct studies involving the relationship of air conditioning and ventilation to industrial hygiene. His assignment was authorized by the U. S. Public Health Service. In his previous assignment with the Ordnance Department, he was responsible for the overall supervision of the engineering phases of the industrial hygiene program in about 90 Army-owned plants employing over 475,000 workers manufacturing, loading, and storing explosives. In this capacity he assisted greatly in the design of adequate ventilating systems for the control of atmospheric health hazards affecting thousands of workers, and contributed substantially to the splendid health record made by the Army Ordnance Department. He has been active on several technical advisory committees, has written extensively in the technical press (H&V, March and May '45).

It's New!

THE AIRTHERM SPACE HEATER

Provides More Efficient . . . More Economical Heat



THE new Airtherm Space Heater provides an even distribution of heat to all parts of the building through high velocity nozzles — is installed with a minimum of installation costs and requires practically no maintenance.

The new Airtherm Space Heater is available in 3 models — for floor mounting (as illustrated) or horizontal or vertical suspension. Choice of gas or oil burners on all models. Capacities from 650,000 to 1,950,000 BTU's per hour.

Write for bulletin describing this new, efficient, money-saving heater, in detail.

AIRTHERM MANUFACTURING COMPANY

722 S. Spring Avenue • St. Louis 10, Missouri

"Killer" CALL BACK

When you use a faulty tee, ell or flange you are extending a special invitation to "KILLER" Call Back, the waster of your time . . . the despoiler of your profits.

In fittings, no other grade but the best yields a profit. "K's" are high grade, thoroughly inspected fittings and when properly installed there are extremely few call backs.

The "K" line is complete . . . every type and size you will require.

COMPLETE LINE. CATALOG ON REQUEST.

- Standard and extra heavy cast iron screwed fittings.
- Standard flanged fittings.
- Standard and extra heavy companion flanges.
- Drainage fittings.

"K" fittings carried in stock at Malleable Iron Fittings Company, Branford, Conn.; M. I. F. stocks at Kuhns Brothers Co., Dayton, Ohio.

KUHNS BROTHERS CO.

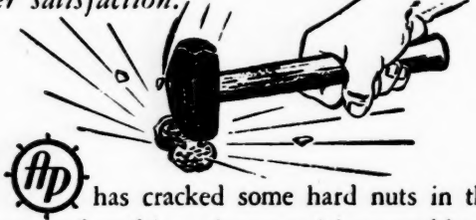
DAYTON 7, OHIO

"WHEN A JOB CALLS FOR MORE THAN ONE EVAPORATOR ON A SINGLE UNIT . . . .

I call for an A-P Model 235 Suction Pressure Valve — It's a good feeling to know what a valve can do . . . *and I know!*"

THAT is the comment from a Refrigeration Service Engineer when we asked him regarding his personal experience with "A-P" Valves.

Confidence like this is based on practical, day-in day-out experience in maintaining the nation's refrigerating machinery in spite of today's difficulties and handicaps. It is a trust shared by a widespread army of refrigeration service engineers who know that dependable "A-P" Controls, Valves, and Solenoids save them time-wasting call-backs — insure *customer satisfaction.*



A-P has cracked some hard nuts in the way of refrigeration servicing problems. Always feel free to consult us about yours!

AUTOMATIC PRODUCTS COMPANY

2462 N. Thirty-Second Street Milwaukee 10, Wisconsin
Export Department — 13 East 40th Street, New York 16, New York

A-P DEPENDABLE REFRIGERANT VALVES

Charles Davies, industrial designer, has been retained as consultant on styling and product engineering by the **United States Air Conditioning Corp.** of Minneapolis, Minn. As president of the Davies Air Filter Corp. from 1930 to 1944, Mr. Davies was responsible for the designing and styling of its various products, which included both industrial and home type appliances.

Captain Ralph E. Lee, recently discharged from the Army Air Corps, is now manager of the export department of **The Trane Co.,** La Crosse, Wis., manufacturers of heating, cooling, air conditioning and heat exchange equipment. Captain Lee, who holds the Distinguished Flying Cross and Air Medal with four Oak Leaf Clusters, left the company's general sales department in March of '42 to enter the service. In addition to the duties involved in re-establishing export sales connections, Lee will be associated with the general sales department in developing the company's sales and advertising programs.

Williams Oil-O-Matic Division, Eureka Vacuum Cleaner Co., announces the appointment of **E. E. Frederick** as national service manager. Mr. Frederick, manager of the plant's standby facilities for ordnance since October 1944, now assumes charge of all field service. In addition, he will head the handling of parts, repairs, factory re-builds, and claims. Mr. Frederick is a veteran of World Wars I and II and holds the commission of major in the inactive reserve of the United States Army. At one time Mr. Frederick was national service manager for the Sterling Motor Car Company, builders of motor trucks. Prior to his Oil-O-Matic connection, Mr. Frederick was with the A. O. Smith Corporation of Milwaukee as assistant to the manager of the St. Paul Propellor Plant. Before entering the army he was with the Smith organization as assistant to the manager of the war facilities division and previous to that as tool and production engineer in the household appliance division.

E. E. Frederick

Marlo Coil Co., St. Louis, has announced the appointment of **Walter B. Moses, Jr.** as regional respresentative in Louisiana, Mississippi, Alabama and Northwestern Florida, effective Sept. 1. Mr. Moses is resuming his commercial and engineering activities after wartime service as assistant naval architect of Pendleton Shipyards Co., Inc., at New Orleans. His headquarters will be at 7836 St. Charles St., New Orleans.

On August 9, **J. J. Donovan** was appointed Eastern divisional manager by **Chrysler Corp., Airtemp Division.** Mr. Donovan was New York regional manager up to the time of his promotion. His new work will be to coordinate the merchandising efforts of the Boston Region, New York Region, Philadelphia Region and Washington Region, all of which together comprise the Eastern Division. Before coming to Chrysler Airtemp, Mr. Donovan was associated with the War Production Board, Washington, D. C., as assistant director of the Automotive Division, prior to which he had wide experience in the refrigeration and air conditioning industry, entering the refrigeration business in 1923 with Frigidaire, which was then a division of Delco Light Corp., following his graduation from Syracuse University. He later joined the electric refrigeration department of the General Electric Co.

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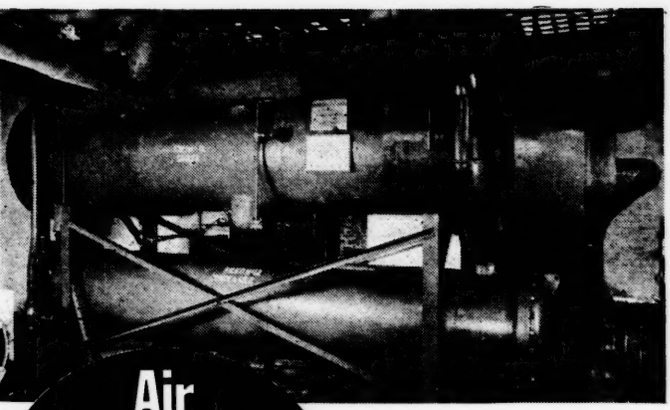
Draftless
AIR DISTRIBUTOR

The only Distributor with the patented curved-vane construction which imparts a circulator motion to the air . . . the Distributor which effectively mixes room air with conditioned air . . . the Distributor which speedily establishes a uniform temperature WITHOUT DRAFT!

Quick Deliveries of
STAINLESS STEEL
ALUMINUM
GALVANIZED IRON
OR ENAMELED
AIR DISTRIBUTORS

CHARLES DEMUTH & SONS
MINEOLA (LONG ISLAND), N. Y.



Air Conditioning HEAT EXCHANGERS

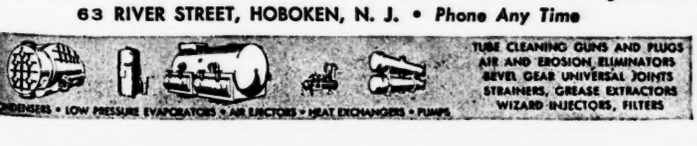
CONSECO

Let our engineering department help you with your problem

Conseco 15 ton freon heat exchanger, Strand Theatre, N. Y.

Twenty years' specialized experience designing, fabricating and servicing heat exchangers assure sound design, quality construction and economical operation with any type refrigerant. Engineering assistance gladly furnished. Write.

CONDENSER SERVICE & ENGINEERING CO., INC.
63 RIVER STREET, HOBOKEN, N. J. • *Phone Any Time*



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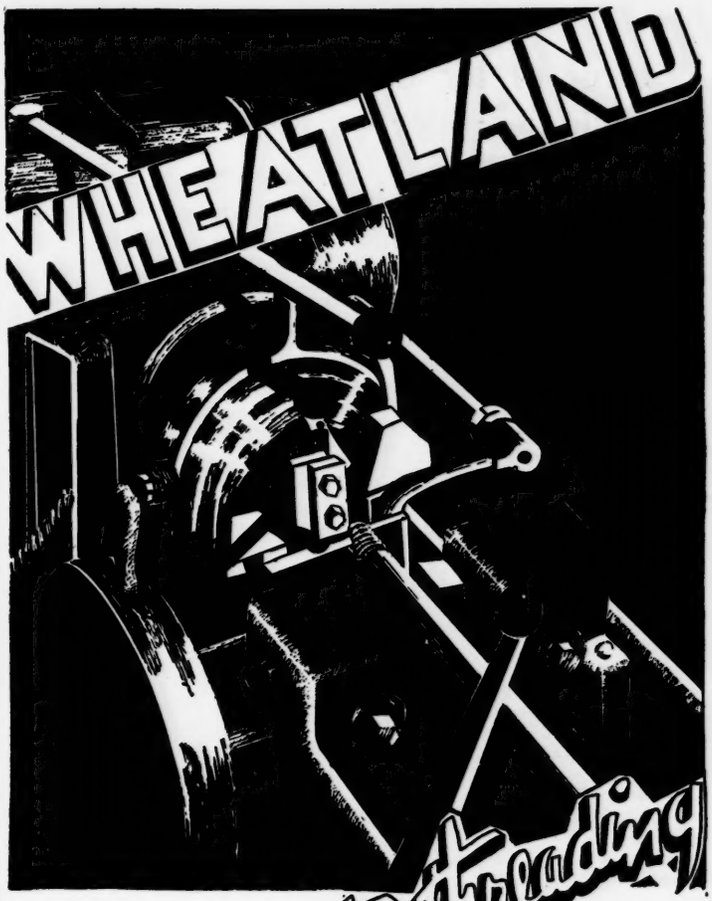
TUBE CLEANING GUNS AND PLUGS
AIR AND EROSION ELIMINATORS
BEVEL GEAR UNIVERSAL JOINTS
STRAINERS, GREASE EXTRACTORS
WIZARD INJECTORS, FILTERS



for accurate threading

"A final process toward making WHEATLAND steel pipe the surpassing product it is, is accurate threading. It is important to underline the quality of our Bessemer free-cutting steel pipe, for it takes quality steel to yield clean and sharp threads."

"The pipe is held in position while rotating chasers, steadily sharpened and lubricated, cut the thread. When the thread length has been reached, the machine automatically kicks off. In order to maintain perfect threads, WHEATLAND pipe is constantly checked by high precision gauges."

"Rely on WHEATLAND for gauged control, thereby assuring yourself of accurate, uniform pipe thread at all times."

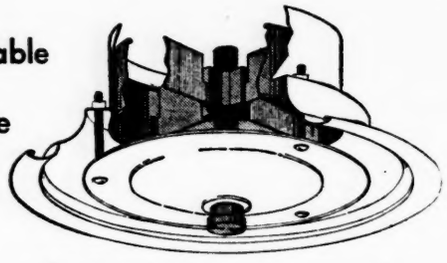
Plant: Wheatland, Mercer County, Pa.
General Offices: Real Estate Trust Building
Philadelphia 7, Pa.

WHEATLAND TUBE COMPANY

Control of air direction and volume
as an aid to satisfactory supply air diffusion

Whether they are used in heating, cooling, ventilating, or combined systems, KNO-DRAFT Diffusers can be adjusted quickly and accurately for system balancing and individual or seasonal requirements. As a result the factors of temperature variation, temperature fluctuation, drafts and noise can be minimized considerably.

Type K Adjustable Diffuser with Type D Volume Damper for supply air.



Pat. and pat. pending

Any desired condition at your fingertip.

Type SR Adjustable Diffuser for supply and return air.

By simply turning the air adjustment screws (easily accessible from under the unit) the inner cone may be raised or lowered to secure any angle of air direction required. A built-in damper, with which either model can be equipped, varies the outlet aperture uniformly without affecting the outlet velocity or diffusion pattern. Thus, the air direction and volume of the same KNO-DRAFT Diffuser can be adjusted to be equally effective in expelling chilled air parallel to the ceiling or ejecting heated air downward to prevent stratification.

With KNO-DRAFT Adjustable Diffusers many engineers have been able to insure efficient air distribution, maximum premixing of room and supply air, noiseless and draftless diffusion and uniform temperature throughout the occupied zone. And they have been able to reduce labor and sheet metal costs by distributing large volumes of air at higher duct velocities in smaller, simplified ducts with fewer outlets, because KNO-DRAFT Diffusers permit the use of higher neck velocities.

The W. B. Connor Engineering Corp. maintains a staff of specialists and district representatives in leading cities to assist you with any air distribution problem.

FREE HANDBOOK

Contains clear sketches, charts, dimension prints and instructive text that simplify the selection and installation of air diffusers. For your copy write Dept. E-8.

W. B. CONNOR ENGINEERING CORP.

Air Diffusion *Air Purification* *Air Recovery*

114 E. 32nd Street — New York 16, N. Y.

A code for rating and testing oil fired residential steel boilers, and for rating commercial boilers has been issued by **Steel Boiler Institute, Inc.**, 366 Madison Ave., New York, N. Y. Residential steel boilers are defined by the code as those containing not more than 177 sq ft of heating surface.

Johns-Manville Corp., has announced plans for a research center near Bound Brook, N. J., across the river from the company's plant at Manville, N. J. The new center, consisting of six buildings on a 93-acre plot, calls for the expenditure of $40,000,000. Buildings planned are a research laboratory and administration building, two combination laboratory-factory buildings, a research engineering and machine shop building, a water filtration and waste processing building, and a garage and stores building. The first structure to be erected will cost $2,000,000.

E. D. Wacker has been appointed general manager of the **C. J. Tagliabue Division, Portable Products Corp.** For the last eight years he has been general sales manager, and has been associated with C. J. Tagliabue for 22 years.

The **A. P. Green Fire Brick Co.** has moved its advertising and public relations department from its general offices and plant at Mexico, Mo., to St. Louis, with offices in the Railway Exchange Building.

Four men have been named to head newly organized sections in **General Electric's** Control Division, new name of the company's former Industrial Control Division, by Karl H. Runkle, manager of the G-E Industrial Divisions.

William M. Anthony is sales manager of the Industry Control section; **Edward S. Bush** is appointed sales manager of the Appliance and Aircraft Control section; **S. V. W. Dockstader** has been named sales manager of the General Purpose Control section, and **William J. Stock** is in charge of the Marketing and Promotion section.

This reorganization has been made so that the Control Division can more efficiently handle the increased volume and variety of control business expected in the postwar period.

Already in existence in the division is the fifth section to make up the control group, the Electronic Control section, with **A. E. Bailey, Jr.**, sales manager. **K. R. Van Tassel** is manager of the newly named Control Division, and **R. S. Glenn** is sales manager.

Mr. Anthony, a native of Newark, N. J., joined General Electric in 1923 at Bloomfield, N. J. He received an engineering degree at Newark Tech in 1929, and, after a few months as a student engineer on the company's test course at Schenectady, entered the Industrial Control division.

Mr. Bush, born in Atco, N. J., became a General Electric employee in 1926 as a student engineer on the test course at Bloomfield. In 1928 he received a bachelor of science degree in electrical engineering from Newark College of Engineering. He has been in the Industrial Control division at Schenectady since 1930.

A native of Pattersonville, N. Y., Mr. Dockstader joined the company in 1903 at Schenectady, and the following year was a testing engineer. In 1910 he transferred to the Supply department, and through changes in the organization setup subsequently became associated with the Industrial Control division.

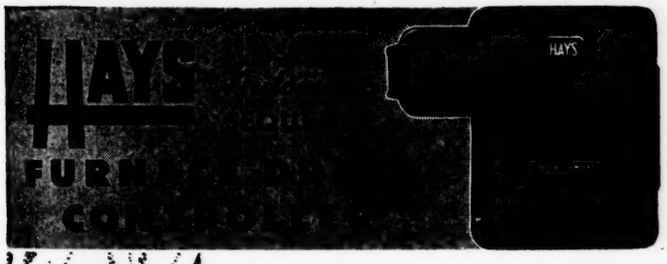
After his graduation from Purdue University in 1916 with the bachelor of science degree in electrical engineering, Mr. Stock came to General Electric in Schenectady as a student engineer on the test course. In 1917 he joined a group that is now the Control division, where he has remained up to the present time. Mr. Stock was born in Elkhart, Ind.

PIPE and TUBE BENDING
WELDING FABRICATION

Many foremost manufacturers, having discovered our specialized skill in our particular line, have entrusted us with a great variety of precision pipe and tube work, including bending, coiling, expanding, flattening, brazing and welding.

Swan engineers and technicians, dealing continually with piping, can advise on your bending requirements and offer valuable suggestions on design and economical methods of installation. We invite your inquiries.

SWAN ENGINEERING CO., Inc.
20-58 NELSON ST., BLOOMFIELD, N. J.



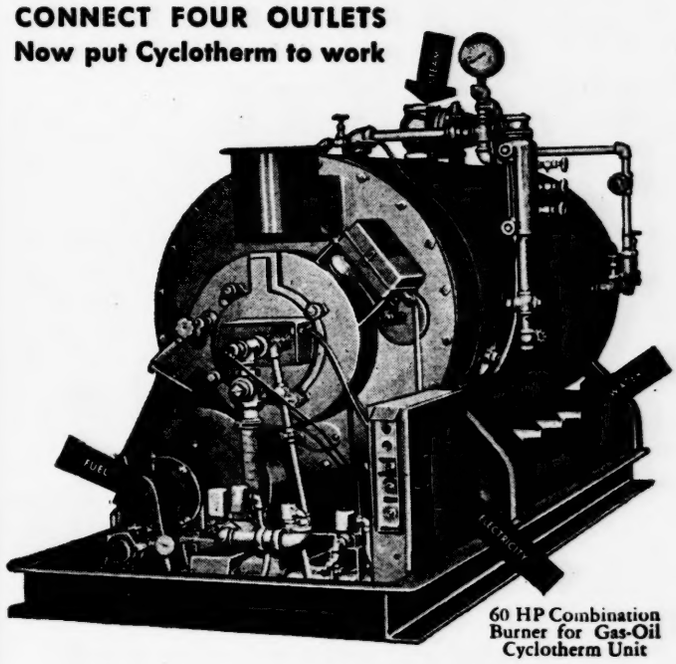
NO BLOW BACK

FOR "ON" AND "OFF" FIRING EQUIPMENT
CONTROLS FURNACE DRAFT AUTOMATICALLY
FOR EFFICIENT COMBUSTION

Provides Automatic Control! In intermittent automatic firing, equipment cannot start under HAYS automatic sequence control until damper is wide open. This eliminates blow backs on either oil or stoker "On" and "Off" type installations. Further, it regulates damper for efficient combustion at all firing stages. Economical, easy to install, widely used in both small and large installations. Full description in HAYS Booklet 41-489. Send for it today.

The HAYS CORPORATION
SINCE 1903 COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

CONNECT FOUR OUTLETS
Now put Cyclotherm to work



60 HP Combination Burner for Gas-Oil Cyclotherm Unit

Order your post-war Cyclotherm now

Cyclotherm Steam Generators are available to industry on a peacetime basis, *without priority for immediate delivery.*

With fuel restrictions lifted, you will want to modernize your power plant with a Cyclotherm Steam Generator.

Whatever your use of steam, the immediate answer is a completely assembled, packaged Cyclotherm unit.

Cyclotherm is emerging from the war with a veteran's reputation for delivering results under all kinds of service conditions. Thousands of Cyclotherm units have been in service throughout the world with the Army, Navy and Marine Corps.

Cyclotherm's record of service is your best guarantee of its builders' engineering "know-how" and the quality built into a Cyclotherm unit.

Cyclotherm units range from 10 HP to 200 HP. They are completely self-contained, automatic, oil or gas fired. They are designed on unique principles of combustion that give top efficiency and service while holding operating and maintenance costs to a minimum. This packaged steam generator will give you years of continuous, trouble-free, economical service.

Orders are being filled promptly.

CYCLOTHERM STEAM GENERATOR

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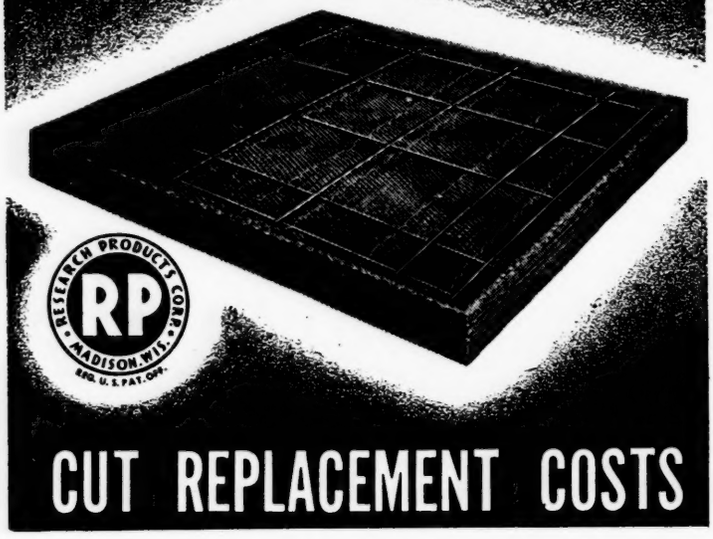
STOP MORE DUST



CUT REPLACEMENT COSTS

RESEARCH AIR FILTERS

For Filter Banks and Industrial Dust Collection

HIGH DUST REMOVAL EFFICIENCY—because the air is reversed 21 times in its journey through the Research Air Filter—impinging on more than 30,000 tiny baffles per square foot. LOW RESISTANCE TO AIR FLOW—surface clogging reduced to a minimum.

Write For This Study

"The Effect Of Dirty Air Filters On The Performance of A Winter Air Conditioning Unit" —shows how clean filters cut heating costs, increases air volume circulation. Sent free on request, together with technical data sheets. Write today!

RESEARCH PRODUCTS CORP.
MADISON 3, WIS.

A new addition to their factory at 340 N. Sacramento Boulevard, Chicago, has been completed by **Rempe Co.**, for the manufacture of their new post-war line of unit blowers for air conditioning and refrigeration and fin coils for low temperature cooling. The new blower line is being made in a large range of sizes and for use with all types of refrigerants including Prestone and brine. Fi coils for temperatures as low as —40F are manufactured for quick freezing of perishable products.

The **United Tube Corp.** of Ohio, manufacturer of welded mechanical tubing, announces the opening of a new plant at 2134 West 53rd Street in Cleveland. Production of mechanical steel and alloy irrigation tubing is already under way.

Starting this fall, a new course is being offered by **Colorado A & M College,** Fort Collins, Colo., on the use of new types of building material in the post war period. The course combines the study of engineering subjects, wood, marketing and business practices and is intended to help those in the building trades.

Announcement of **Howard C. Curran's** appointment as midwestern district representative has just been made by the **Williams Oil-O-Matic Division, Eureka Vacuum Cleaner Co.** Mr. Curran's background includes 21 years of sales and advertising experience with Western Electric of Chicago, The Chicago Tribune, Chicago Journal of Commerce, the Tri-City Star, Davenport Newspapers, and Kane Advertising Agency. Immediately upon the completion of his training at the Oil-O-Matic home office and factory in Bloomington, Illinois, Mr. Curran will begin work in his territory.

Joseph C. Cooper has been appointed a New England district representative for Oil-O-Matic. Mr. Cooper's extensive oil heating experience in the New England area dates back to 1925 when he joined Petroleum Heat & Power Company, as a salesman. In 1930 he went with Gilbert & Barker Manufacturing Company as a divisional sales manager. Previous to his Oil-O-Matic connection, Mr. Cooper was sales manager for Bemis & Call Company.

Launching the largest advertising campaign in the company's history to promote the use of oil for home heating, **Socony-Vacuum Oil Co., Inc.** has selected 364 newspapers in the New England and Middle Atlantic States to push the use of fuel oil in this area. Total combined circulation of the media selected is 12,801,000. The advertising campaign will continue through April.

Production of Fresh'nd-Aire circulators has been stepped up to 50 units per hour and the plant has been put on a 12 month schedule, according to **J. D. Allen,** General Sales Manager, **Fresh'nd-Aire Co.,** Chicago. This represents a radical reparture in the manufacture of air circulators, normally a seasonal appliance.

The Conference "Instrumentation and the University" sponsored by the **Carnegie Institute of Technology** and **The Instrument Society of America** will be held in the Industries Building at the Carnegie Institute of Technology, October 16 to 18, 1945, it was announced by Dr. Webster Jones, Director of the College of Engineering. The chairman of the committee is Dr. B. R. Teare, Jr., head of the department of electrical engineering of the Carnegie Institute of Technology, Pittsburgh 13, Pa. Attendance at the Conference must be limited due to the size of the meeting room. Therefore, applications for attendance must be sent to Dr. Teare and invitations will be sent in the order in which applications are received until the limiting number is reached.

C. G. Phelps, secretary-treasurer of the Wolverine Brass Works, Grand Rapids, has been elected president of the Western Michigan Control of the **Controllers Institute of America.**

At the annual meeting of the Institute's Philadelphia Control, **J. Walton St. Clair,** vice-president of the Hajoca Corp., was elected president. **Edward L. Fortin,** treasurer of the Selas Corp. of America, was chosen a director.

P. H. Wernicke, assistant controller of the Minneapolis-Honeywell Regulator Company, has been chosen first vice-president of the Twin Cities Control of the Institute.

Fred F. Hoyt, vice-president of the Carrier Corporation, has been reelected a director of the Syracuse Control. **John H. Baker,** assistant controller of the company, was elected secretary-treasurer.

William B. Harrell, auditor of the Louisville Tin & Stove Co., is now the secretary of the controllers' local organization in that city, and **Ben R. Shaver,** treasurer of the American Air Filter Co., Inc., has been named a director.

Eugene P. Heiles, controller of the Surface Combustion Corp., has been elected secretary-treasurer of the Institute's Toledo Control. **F. K. Zimmerman,** treasurer of the Lynch Manufacturing Corp., Defiance, Ohio, was chosen to the board of directors.

Philip W. Scott, secretary-treasurer of the Bryant Heater Company, has been reelected a director of the Cleveland Control of the Institute.

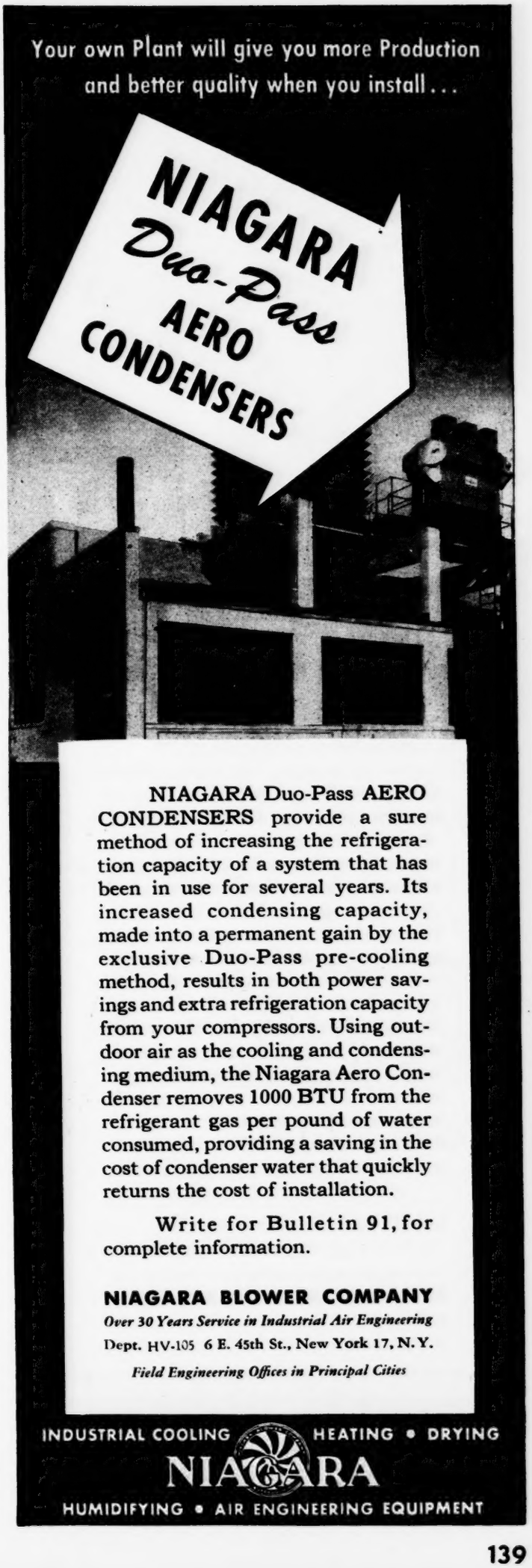
A post war program that will more than double its present manufacturing facilities has been announced by **The Trane Co.,** La Crosse, Wis. A new addition will be built to the main plant and this will increase the plant size 40%. It will permit the fabrication of heating and air conditioning units on an assembly line basis. A second new building will house factory office workers. Trane has purchased the large factory building that it has leased during the war for the production of heat exchanger equipment for airplanes. The area will now be used for the production of heating specialties.

Swan Engineering Co., Inc., announce that beginning September 1, 1945, all manufacturing and office facilities will be consolidated in a new plant at 22-58 Nelson St., Bloomfield, N. J., without interruption of service to customers.

A. E. Whitney has recently joined the **Herbert H. Davis Co.,** Cicero, Ill., as vice-president and general sales manager. He comes from Dravo Corp., Pittsburgh, Pa., where he served as sales manager of the Heater Department, following 12 years' association with the Iron Fireman Manufacturing Company, Cleveland, Ohio. The Davis Company will manufacture a complete line of direct fired heaters ranging in capacity from 75,000 to 2,000,000 Btu per hour, and for all types of fuel.

After three years as a Major in the Production Division, ASF in Washington, **E. K. Stevens** has returned to his position as Associate Manager of the **International Heating and Ventilating Exposition.** This Exposition is managed by International Exposition Company with headquarters at Grand Central Palace, New York.

A dinner complete with frozen foods was served those who attended the Connecticut Valley Section **A.S.R.E.** meeting held September 20 at the Hotel Sheraton, Springfield, Mass. The entire meeting was devoted to the subject of home freezers. At the October 18 meeting to be held at the Hartford City Club, Hartford, Conn., A. K. Phillipi of Westinghouse will talk on furnace brazing and induction heating.


Your own Plant will give you more Production and better quality when you install...
NIAGARA
Duo-Pass
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CONDENSERS
NIAGARA Duo-Pass AERO CONDENSERS provide a sure method of increasing the refrigeration capacity of a system that has been in use for several years. Its increased condensing capacity, made into a permanent gain by the exclusive Duo-Pass pre-cooling method, results in both power savings and extra refrigeration capacity from your compressors. Using outdoor air as the cooling and condensing medium, the Niagara Aero Condenser removes 1000 BTU from the refrigerant gas per pound of water consumed, providing a saving in the cost of condenser water that quickly returns the cost of installation.
Write for Bulletin 91, for complete information.
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Over 30 Years Service in Industrial Air Engineering
Dept. HV-105 6 E. 45th St., New York 17, N.Y.
Field Engineering Offices in Principal Cities
INDUSTRIAL COOLING HEATING • DRYING
NIAGARA
HUMIDIFYING • AIR ENGINEERING EQUIPMENT

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TEMPERATURE and HUMIDITY
CONTROL

When you want accurate and dependable automatic temperature or humidity control for Heating, Ventilating and Air Conditioning Systems or Industrial Processes call in a Powers engineer. With a very complete line of self-operating and compressed air operated controls we are well equipped to fill your requirements.

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★ Over 50 Years ★
of Temperature and Humidity Control

IMPROVE FAN PERFORMANCE
WITH
Meier Nu-air
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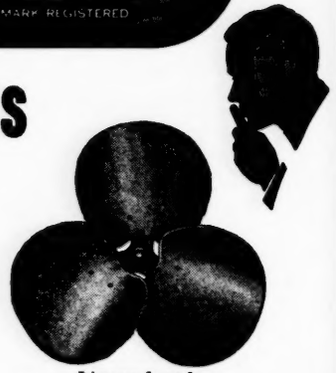
Quiet PROPS



The manner of performance is what interests you in propeller blades. Quiet performance . . . first-rate air delivery with only a whisper of sound. Meier Nu-Air blades are insulated from the spider and hub . . . near-mirror finish aluminum; the spider is cadmium plated . . . all propellers are static balanced and guaranteed to be accurate. These are only a few of the qualities that help make Quiet Props mean quiet performance. Meier Nu-Air Props are available in sizes from 10" to 54" and pitch from 11° to 34°. For further details, write for Bulletin No. 2100.

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Meier ELECTRIC & MACHINE CO.
3525 E. WASHINGTON STREET
INDIANAPOLIS, INDIANA

E. A. Vallee, vice-president and general manager of the **Automatic Products Co.**, Milwaukee 10, Wis., recently sketched a promising and enthusiastic picture of the possibilities for growth in the field of low temperature controls and equipment. Not only have there been no reductions in personnel in this department at "A-P", but new additions are being made to the force to handle the upswing in production schedules required to meet the great backlog of demand for control equipment of all kinds.

The nation-wide expansion of the frozen-food markets as well as locker plants for family storage that will take place in the coming months and years, Mr. Vallee believes, will virtually revolutionize the food buying habits of city and rural dwellers alike.

Another field closely allied with food refrigeration that is due to make giant strides in the near future, Mr. Vallee reports, is the air conditioning field. Systems not only for public buildings and retail, industrial, and office structure installation, but for the medium-class residence will become more and more commonplace within the next few years, and installation and maintenance costs will be substantially reduced. As a result, this segment of the general refrigerating equipment field will require vast quantities of refrigerant controls designed for air conditioning systems.

The Alco Valve Co., of St. Louis, Mo., will retain all of its 500 wartime employees and add more to take care of peacetime demand for the valves and other products that it makes for air-conditioning and refrigeration equipment, Russell Maguire, owner of the company has announced.

Mr. Maguire disclosed that capitalization of the company is being quadrupled from $108,000 to $432,000 by the transfer of funds from surplus to capital and that the enlarged quarters at 865 Kingsland Avenue, St. Louis, to which Alco moved during the war, will be retained.

The **Anthracite Industries, Inc.**, has announced appointment of **Emmett Mulroy** as field representative with headquarters in Syracuse to cover the territory formerly covered by the late Edward G. Freidell, who died recently. A graduate of Syracuse University, College of Applied Science, Civil Engineering, Mr. Mulroy has handled sales and service for Kelley Brothers, Syracuse coal merchants, during the past seven years.

The Industrial Oven Engineering Co., of Cleveland, has opened a branch office in Chicago, located at 332 South Michigan Ave. This firm designs and manufactures all types of ovens and oven processing systems for temperatures up to 1000° F., specializing in complete coating and impregnating systems for wire, cable, rope, tape, textiles, rubber, synthetics, and other continuous materials. In charge of the Chicago office are **H. W. Munday** and **F. T. Greaves**, both graduate engineers and specialists in industrial heating problems. Mr. Munday is a director of the Armour Research Foundation and a trustee of the Illinois Institute of Technology.

According to records maintained by the **Pipe Fabrication Institute**, the industry should have increased post war business. This is based on the fact that a large amount of utility business is expected, plus tremendous repair and maintenance orders, and a large amount of orders from the export field. Some government orders are also being completed. It is expected by the institute that heating, piping and air conditioning contractors are going to be exceedingly busy. Considerable activity is expected in the refrigeration field. The institute held a regional meeting in New York City recently.

The Sawhill Mfg. Co., Sharon, Pa., has completed an expansion program to meet the demands of peacetime business. Sawhill specializes in "pre-fabrication" of pipe, also manufactures special pipe fittings for the plumbing and heating industry and serves as a jobber and distributor for pipe.

Paul Henry Co., 2037 South La Cienega Blvd., Los Angeles 34, Calif., announce the appointment of **Albert E. Baak** as executive director of their controls division. Mr. Baak has been associated with the Minneapolis-Honeywell Regulator Company for the past 12 years. He is a development engineer on temperature and pressure controls.

The Edward Valve & Mfg. Co., Inc., East Chicago, Ind., has appointed **Leatherman & Mertz** as its representatives for all of Michigan, excluding the upper peninsula. The firm of Leatherman & Mertz is headed by Lloyd R. Leatherman and Charles M. Mertz. Offices are in the Book Building, Detroit 26, Michigan.

I. A. Deutch, for the last 20 years a member of the Chicago department of smoke inspection and abatement, has been appointed air pollution engineer for Los Angeles County, with direction over technical investigations to determine the source of noxious gases and smoke and responsibility for recommending methods of abatement. The County Board of supervisors has under consideration an ordinance providing for control and reduction of the air pollution menace. Under the measure, violations would be punishable by a fine of not less than $5 or more than $200 for each offense. The provisions of the county measure parallel, in some respects, those of a proposed ordinance for the city of Los Angeles that would have as its purpose the elimination of visible smoke from industrial plants and other sources. The city council has been requested for an appropriation of $24,600 for purchase of experimental testing and photographic equipment seeking to trace the sources of smoke and fume irritants that cling in the air close to the ground under atmospheric conditions that are peculiar to summer and autumn in Los Angeles.

The board of directors of **Oil-Heat Institute of America, Inc.**, held a quarterly meeting in New York, recently. Twenty-four members of the board were present and **President W. A. Matheson** presided.

After a report by Frank Faust, chairman of the engineering committee, the board appropriated $3,000 for the production of the first combustion reference test unit. This unit is designed to take a place in the industry comparable to the Waukesha Engine in the automotive industry. Mr. Faust reported that the program for testing of catalytically-produced fuel oils was complete in all but two of the thirty-four laboratories involved. This project is in cooperation with ASTM and results of tests will be collated by Oil-Heat Institute.

Sterling Smith, for the last 20 years in the commercial and industrial refrigeration industry, has announced his resignation as manager of the refrigeration division, **Mills Industries, Inc.**, Chicago.

Appointments to two standing committees of the **Stoker Manufacturers' Association** for the ensuing year were announced recently by Walter Sormane, Mendota, Illinois, president of the association. These appointments were made following the recent annual meeting of the Association held in Chicago. Mr. Sormane announced appointments to the association's Engineering and Research Committee and the Advertising and Public Relations Committee.

Push pipe *under* streets, sidewalks, lawns, concrete flooring and other obstacles . . . with a one-man-operated GREENLEE Hydraulic Pipe Pusher.

Eliminate tearing up, tunneling, back-filling, tamping, re-paving. No extensive trenching, as short ground opening accommodates Pusher.

Cut costs greatly, save time and inconvenience to yourself, property owners and the public. The GREENLEE is easily operated by one man. Easy to carry and set up. Pays for itself on first few jobs.

Powerful GREENLEE Hydraulic Pipe Pushers develop up to 75 tons pressure for your big jobs and operate at six speeds for varying soil conditions. Get complete facts, write for free booklet S-117. Greenlee Tool Co., Division of Greenlee Bros. & Co., 2330 Twelfth St., Rockford, Ill.

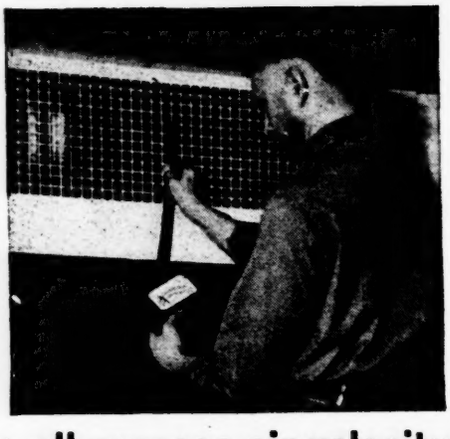
Get Ready with Greenlee!

REGISTERED TOOLS

GREENLEE

FOR THE CRAFTSMAN

Alnor VELOMETER



★ all purpose air velocity meter

Instantaneous, direct readings of air speed measured in feet per minute with the *Alnor* Velometer give you the quick, accurate information on air movement needed to check operation of blowers, fans, air conditioning installations, and similar equipment. No calculations, no timing, no conversion tables; read velocities direct from the Velometer scale. Extension jets permit accurate readings in many locations that would be completely inaccessible with other means of measurement.

The Velometer is made in several standard ranges from 20 fpm to 6,000 fpm, and up to 3 inches static or total pressure. Special ranges available as low as 10 fpm and up to 25,000 fpm velocity and 20 inches pressure.

Write for Bulletin No. 2448-E.

Illinois Testing Laboratories, Inc.

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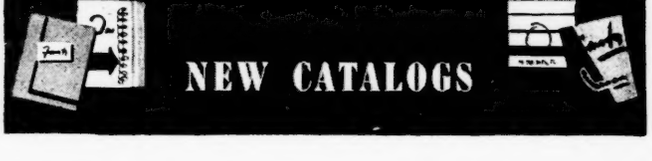
NEW Series 12
Downblow UNIT HEATERS
FOR installations 15 to 45 ft. above working zone. Circular & square types. Copper tubes and copper fins. . . . Write for Catalog 12C-1.
FEDDERS
BUFFALO

Air Control Products, Inc., Coopersville, Mich. (manufacturers of registers, grilles, ventilators, air conditioning units and accessories), announces that construction has been started on a new plant to be located at Grand Rapids, Mich. The new plant will be of modern construction and will ultimately have 200,000 sq ft of floor space. The plant and equipment will be of the latest type and will have assembly bays one block long to provide efficient conveyor line production. It is expected that the new plant will be in operation about December 1st. The main office of the company will remain at the Coopersville plant.

William C. Van Cleaf has been appointed director for industrial relations for the **Allis-Chalmers Mfg. Co.**, it was announced recently. Prior to his appointment, Mr. Van Cleaf served as assistant to Lee H. Hill, former head of industrial relations who resigned. Van Cleaf entered Allis-Chalmers employment in 1912 as an electrical apprentice. Following completion of his indenture, he worked in the service and erection department. Later, he was promoted to assistant foreman on the electrical test floor. Appointed general supervisor of apprentice training, he was soon made company employment manager. With reorganization of the industrial relations division, Van Cleaf was made assistant to Hill. Active in management and industrial relations organization, he is a member of the Society for the Advancement of Management, Industrial Relations Association of Wisconsin, American Management Association, Employer's Association, and the Allis-Chalmers Foreman's Club.

Roots-Connersville Blower Corp. is making extensive improvements in its offices at the plant in Connersville, Ind.

La-Del Conveyor & Manufacturing Co., New Philadelphia, Ohio, announces appointment of **Fred W. Blaisdell** as plant manager. Mr. Blaisdell, who already has taken over his new duties, is well-known in Chicago industrial circles, having served in various production and personnel capacities in that area.



Welding Accessories

An up-to-date price list and catalog of Airco gas welding and cutting supplies and accessories, this 16-page booklet contains illustrations, descriptions, engineering data, and current prices. Types of equipment covered include welding rods, brazing and welding flux, hose, brazing alloys, goggles and spectacles, gloves for gas welding and cutting, and sparklighters and tips. Also listed are: carbon rods and plates, hardfacing rods, cobalt borium inserts, pea borium, and other items.—*Air Reduction, 60 East 42nd St., New York 17, N. Y.*

Convector Radiation

A four-page illustrated bulletin showing variety of installations of Modine built-in convector radiation.—*Modine Mfg. Co., Racine, Wis.*

Electric Motor Maintenance Equipment

A 36-page catalog of electric motor maintenance and testing equipment showing winder heads, cleaning and resurfacing stones, soldering tools, wire strippers, etc.—*Ideal Commutator Dresser Co., Sycamore, Ill.*

Powder Metallurgy

In the Durex manual, a book of 56 pages, is presented practical information for engineers and designers of Durex materials, metal powder parts and a simple explanation of powder metallurgy. It contains bearing application data of interest to designers.—*Moraine Products Division, General Motors Corp., Dayton 1, Ohio.*

Silicones

A 12-page booklet describing the silicones produced by the company in the form of fluids, greases, compounds, resins and varnishes. The silicones extend permissible operating temperatures far above and below those at which comparable organic materials are serviceable.—*Dow Corning Corp., Midland, Mich.*

Wall Temperature Indicator

A single-sheet nomograph chart for determining inside wall temperatures from given "U" values and inside-outside air temperature. Examples clarify this chart.—*National Mineral Wool Association, 1270 6th Ave., New York 20, N. Y.*

Pumps

Packingless, self-priming, centrifugal pumps are described with installation and operating information in Bulletin No. 51 on type "G" pumps.—*The LaBour Co., Inc., Elkhart, Ind.*

Process Temperature Controls

A new bulletin No. 451 describing temperature controls for tank and process installations has been released by Sterling, Inc. The new bulletin contains complete data on sizes, capacities and temperature ranges as well as photographic illustrations and dimensional drawings.—*Sterling, Inc., 3738 N. Holton St., Milwaukee 12, Wis.*

Leather Packings

Graton & Knight Co. offers in file size folder form a series of 12 articles, titled "Packings Pointers." This folder gives much helpful information for the design engineer in respect to the selection of cup, flange, U, and Vee Packings. Also included is illustrated text on the correct design of machine parts adjacent to mechanical packings.—*Packings Department, Graton & Knight Co., 375 Franklin St., Worcester 4, Mass.*

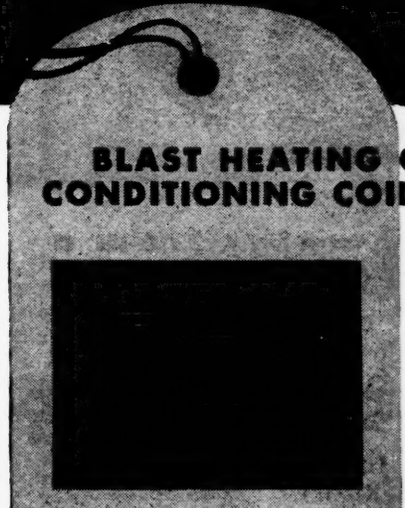
Refractories

Bulletin No. 845 shows four pages of description and installation drawings of Durabilt Refractory products for industrial furnaces.—*Chicago Fire Brick Co., 1419-1467 N. Elston Ave., Chicago 22, Ill.*

Coal Pulverizing

Industrial coal consumers are warned in an open letter from Fairmont Coal Bureau that coal pulverizing equipment for postwar plants should be selected for greater latitude in coal selection than prewar plants required. Transmitted with the letter was the Bureau's "Reference Bulletin Number Six," a concise analysis of the factors to be considered in the selection of pulverizing equipment.—*Fairmont Coal Bureau, 122 East 42nd St., New York 17, N. Y.*

McCORD
HEATING AND AIR CONDITIONING PRODUCTS



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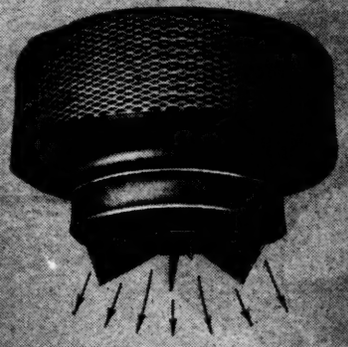

A proven heating unit, modern in design, incorporating every unit heater advancement. McCord copper spiral fin tube construction creates air turbulence without undue restriction. Improved fan blades deliver large volume of air with minimum air noise. Guaranteed for 150 lbs. saturated steam pressure. Specify McCord.

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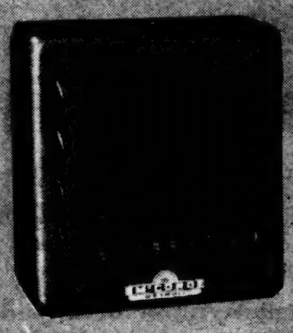

A time proven heating unit, modern streamlined in design, quiet, yet its rugged construction adapts it to all types of installations, guaranteed for use on No. 150 p. s. i. steam pressure. All copper heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Wide range of capacities.

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Thermostats and Pressure Switches

A "Condensed Catalog and Price Sheet" describing thermostats and pressure switches. — *United Electric Controls Co., 69-71 A St., Boston 27, Mass.*

Water Treatment

Bulletin No. 33, entitled "The Modern Way to Avoid Boiler Troubles," is now being released to show how All-Colloidal Water Treatment can result in more efficient and lower-cost steam generation, elimination of shutdowns, preservation of equipment, and improved steam purity.—*American K.A.T. Corp., 331 Madison Ave., New York 17, N. Y.*

Fine Dust Collection

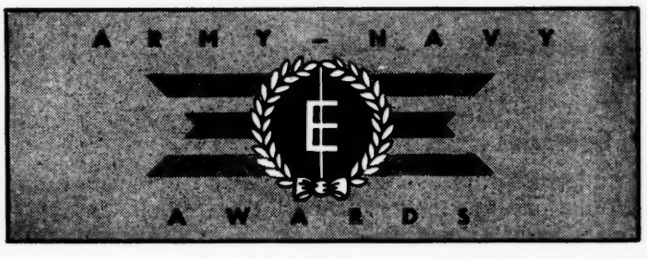
A new bulletin No. 101 issued by Aerotec Co., deals with the problem of fine dust collection, particularly in the range 325 mesh screen or finer. Included are precipitating tests on various dusts in the industrial field, various powdered foods and chemicals. Also shown are the sizes available in Aerotec units from single tubes to 100,000 C.F.M.—*Thermix Engineering Co., First National Bank Building, Greenwich, Conn., Project and Sales Engineers for the Aerotec Co.*

Air Conditioning Economy

A new data folder contains a case history of the application of Dorex Air Recovery equipment to an existing system. With facts, figures and installation drawings, Merle Bennett, Chief Engineer of the Detroit Bank Building, tells how fuel, energy and equipment were saved. Besides the case history, it contains data on ventilation requirements and a typical cost comparison chart showing the savings in money, material and equipment on a new installation. The folder is of the standard file size and may be kept for ready reference. —*W. B. Connor Engineering Corp., 114 East 32nd Street, New York City.*

Electronic Air Filtration

A semi-technical discussion under the title, "The Magic of Electronics in Air Filtration," fully illustrated in color, gives the history, theory and practice of electronic methods of removing entrained solids from air.—*American Air Filter Co., Inc., First and Central Avenues, Louisville 8, Ky.*



Taco Heater, Incorporated, New York, N. Y.

Wales-Strippit Corporation, 345 Payne Ave., No. Tonawanda, N. Y. (Second star)

Buffalo Pumps, Inc., Buffalo 5, N. Y. (Fifth star)

Alliance (Ohio) Gun Mount Plant of The Babcock and Wilcox Co., New York, N. Y. (Fourth renewal)

Ilg Electric Ventilating Co., Chicago, Ill. (Fourth star)

COMING EVENTS

OCTOBER 16-18—Educational Conference on Instrumentation sponsored by the Carnegie Institute of Technology and The Instrument Society of America, to be held in the Industries Building at Carnegie Institute of Technology. Further information from Dr. B. R. Teare, Jr., Head of Department of Electrical Engineering, Carnegie Institute of Technology, Pittsburgh 13, Pa.

OCTOBER 16-18—Smoke Abatement and Fuel Conservation Conference to be held at the Hotel Deshler-Wallic, Columbus, Ohio. Address Frank Chambers, secretary, Smoke Prevention Association of America, Inc., 139 North Clark St., Chicago 2, Ill.

NOVEMBER 14-16—Conference on heating, housing and fuels, sponsored by the Division of Fuel Technology of the School of Mineral Industries at The Pennsylvania State College, State College, Pa. Conference will consist of five sessions dealing with housing needs, basic elements of construction for heating with solid fuels, advances in heating equipment, engineering and research developments, and merchandizing trends. Further information from Dr. H. B. Charmbury, Mineral Industries Bldg., State College, Pa.

DECEMBER 10-12—Annual meeting of the American Society of Refrigeration Engineers, Hotel Pennsylvania, New York City. David L. Fiske, Secretary, 40 W. 40th St., New York 18, N. Y.

JANUARY 28, 1946—Annual Convention of the American Society of Heating and Ventilating Engineers, to be held in New York City. Hotel and length of convention still to be decided.

MARCH 4-7, 1946—Open meeting of Refrigeration Equipment Manufacturers Association membership with refrigeration jobbers and service engineers, at the Stevens Hotel, Chicago. For further information address Theodore R. Sills, Refrigeration Equipment Manufacturers Association, 43 East Ohio Street, Chicago 11, Ill.

MAY 7-9, 1946—Annual meeting and convention of the National Association of Corrosion Engineers, with headquarters in the President Hotel, Kansas City, Mo. In addition to technical programs there will be an exhibtion of corrosion-resistant, corrosion-mitigation and various types of protective materials in the Main Arena of the Municipal Auditorium.. Further information from Elton Sterrett, executive secretary, 318 Southern Standard Building, 711 Main Street, Houston 2, Texas.

OCT. 28-NOV. 1, 1946—REMA annual all-industry refrigeration and air conditioning show to be held in the Cleveland Public Auditorium, Cleveland, Ohio. Further information from Refrigeration Equipment Manufacturers Association, 43 East Ohio Street, Chicago 11, Ill.

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